Arts & Crafts
Weaving

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INTERNATIONAL LIBRARY OF TECHNOLOGY

A SERIES OF TEXTBOOKS FOR PERSONS ENGAGED IN THE ENGINEERING PROFESSIONS AND TRADES OR FOR THOSE WHO DESIRE INFORMATION CONCERNING THEM. FULLY ILLUSTRATED AND CONTAINING NUMEROUS PRACTICAL EXAMPLES AND THEIR SOLUTIONS

GLOSSARY OF WEAVES
ELEMENTARY TEXTILE DESIGNING
ANALYSIS OF COTTON FABRICS
ANALYSIS OF WOOLEN AND WORSTED FABRICS
TWILL WEAVES AND DERIVATIVES
SATIN AND OTHER WEAVES
COMBINATION WEAVES
CONSTRUCTION OF SPOT WEAVES
WEAVES FOR BACKED COTTON FABRICS
WOOLEN AND WORSTED PLY WEAVES
LENO WEAVES
PILE WEAVES
COLOR IN TEXTILE DESIGNING
DESIGNING IN GENERAL

SCRANTON:
INTERNATIONAL TEXTBOOK COMPANY
81

92 Printed in the United States. 224

PREFACE

The International Library of Technology is the outgrowth of a large and increasing demand that has arisen for the Reference Libraries of the International Correspondence Schools on the part of those who are not students of the Schools. As the volumes composing this Library are all printed from the same plates used in printing the Reference Libraries above mentioned, a few words are necessary regarding the scope and purpose of the instruction imparted to the students of—and the class of students taught by—these Schools, in order to afford a clear understanding of their salient and unique features.

The only requirement for admission to any of the courses offered by the International Correspondence Schools, is that the applicant shall be able to read the English language and to write it sufficiently well to make his written answers to the questions asked him intelligible. Each course is complete in itself, and no textbooks are required other than those prepared by the Schools for the particular course selected. The students themselves are from every class, trade, and profession and from every country; they are, almost without exception, busily engaged in some vocation, and can spare but little time for study, and that usually outside of their regular working hours. The information desired is such as can be immediately applied in practice, so that the student may be enabled to exchange his present vocation for a more congenial one, or to rise to a higher level in the one he now pursues. Furthermore, he wishes to obtain a good working knowledge of the subjects treated in the shortest time and in the most direct manner possible.

In meeting these requirements, we have produced a set of books that in many respects, and particularly in the general plan followed, are absolutely unique. In the majority of subjects treated the knowledge of mathematics required is limited to the simplest principles of arithmetic and mensuration, and in no case is any greater knowledge of mathematics needed than the simplest elementary principles of algebra, geometry, and trigonometry, with a thorough, practical acquaintance with the use of the logarithmic table. To effect this result, derivations of rules and formulas are omitted, but thorough and complete instructions are given regarding how, when, and under what circumstances any particular rule, formula, or process should be applied; and whenever possible one or more examples, such as would be likely to arise in actual practice—together with their solutions—are given to illustrate and explain its application.

In preparing these textbooks, it has been our constant endeavor to view the matter from the student's standpoint, and to try and anticipate everything that would cause him trouble. The utmost pains have been taken to avoid and correct any and all ambiguous expressions—both those due to faulty rhetoric and those due to insufficiency of statement or explanation. As the best way to make a statement, explanation, or description clear is to give a picture or a diagram in connection with it, illustrations have been used almost without limit. The illustrations have in all cases been adapted to the requirements of the text, and projections and sections or outline, partially shaded, or full-shaded perspectives have been used, according to which will best produce the desired results. Half-tones have been used rather sparingly, except in those cases where the general effect is desired rather than the actual details.

It is obvious that books prepared along the lines mentioned must not only be clear and concise beyond anything heretofore attempted, but they must also possess unequaled value for reference purposes. They not only give the maximum of information in a minimum space, but this information is so ingeniously arranged and correlated, and the

indexes are so full and complete, that it can at once be made available to the reader. The numerous examples and explanatory remarks, together with the absence of long demonstrations and abstruse mathematical calculations, are of great assistance in helping one to select the proper formula, method, or process and in teaching him how and when it should be used.

This volume deals with the classification, analysis, and construction of the principal weaves. Beginning with a comprehensive collection of weave varieties, there follows an outline of the principles of designing. Then, methods are indicated by which the construction and material of cotton, woolen, and worsted cloth samples may be ascertained. The following varieties of weaves are taken up next and considered in detail: twill weaves and derivatives, satin and its derivatives, combination weaves, spot weaves, backed cotton fabrics, woolen and worsted ply weaves, leno weaves, and pile weaves. These descriptions are followed by others that explain the effects of colors in designs. After a classification of the colors, there follow descriptions of their attributes, of the influence of the nature of the fibers on color, and of the application of colors to textiles. Definitions are also given of simple and compound colorings, with instructions for the design of stripes, checks, and spots. The volume closes with practical rules relating to the duties of a designer and the equipment of a designing room.

The method of numbering the pages, cuts, articles, etc. is such that each subject or part, when the subject is divided into two or more parts, is complete in itself; hence, in order to make the index intelligible, it was necessary to give each subject or part a number. This number is placed at the top of each page, on the headline, opposite the page number; and to distinguish it from the page number it is preceded by the printer's section mark (§). Consequently, a reference such as § 16, page 26, will be readily found by looking along the inside edges of the headlines until § 16 is found, and then through § 16 until page 26 is found.

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GLOSSARY OF WEAVES

INTRODUCTION

The **weave,** or method of interlacing the warp and filling yarns, is, in the majority of fabrics, of primary importance, since it not only determines the actual structure of the cloth, but also greatly affects its ultimate appearance. Thus, fabrics composed of warp and filling yarns of the same material and counts vary greatly in appearance if woven with a plain weave or with a twill weave, etc. In designing fabrics of various types and constructions, it frequently happens that difficulty is experienced in obtaining a suitable weave with which to construct the cloth. It is also of great advantage to the designer if, when designing a fabric, a weave can be selected from a number of weaves that will give the best result and is best suited to the type of fabric that it is desired to produce. The utility of a collection of the more common and valuable weaves used in textile designing, arranged and classified in a comprehensive manner, is therefore readily apparent. In this glossary, a large number of valuable weaves are given, classified according to the number of ends on which they are complete. Thus, in case a designer is laying out a fabric that it is desired shall be woven with a weave complete on 8 ends, a large number of weaves complete on this number of ends are available, from which a suitable weave may be selected. It will be understood that this collection of weaves does not contain every known weave, since it is possible to construct many thousands of different weaves; in fact, the number of weaves that may be

made is unlimited. The collection of weaves given, however, is complete enough for all ordinary purposes and contains examples of those types in most frequent use and that are therefore of more particular importance. While in some cases it may be found that none of the weaves contained in the glossary exactly meet the requirements of a designer who wishes to produce a certain fabric, yet the weaves shown will often be of service in suggesting new ideas for the construction of a weave suitable for the cloth that it is desired to produce, or it may even be found that a slight alteration of some one of the weaves shown will so change its structure and the effect that it will produce in a fabric as to render it perfectly adapted to the purposes of the designer. The weaves given are numbered consecutively, and throughout the following Sections dealing with the various features of textile designing, frequent reference is made to them.

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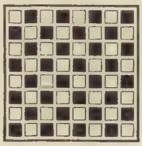
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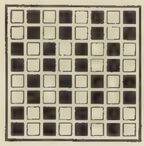
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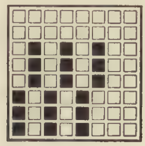
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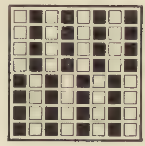
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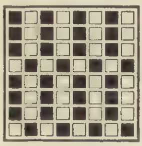
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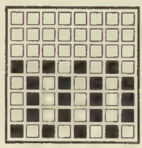
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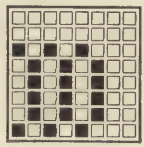
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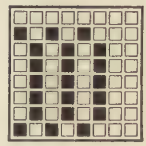
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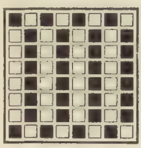
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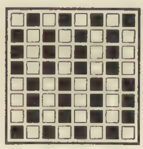
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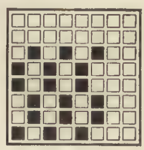
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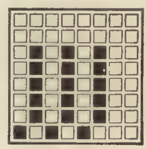
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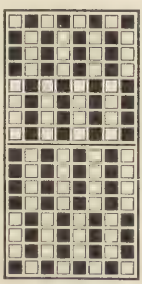
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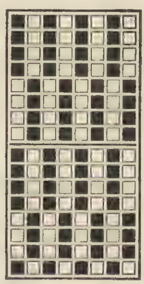
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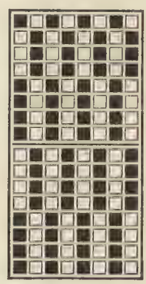
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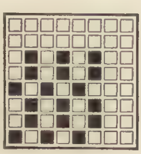
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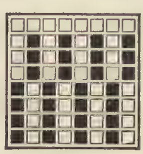
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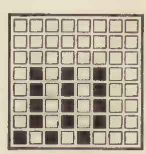
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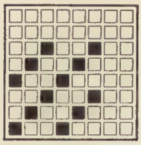

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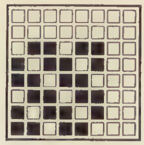

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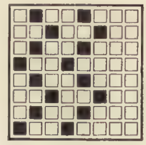

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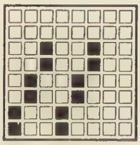

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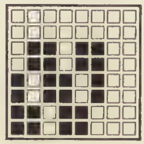

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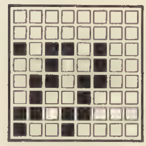

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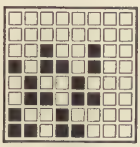

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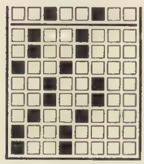

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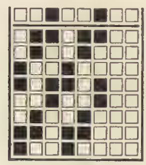

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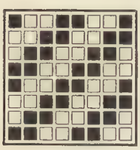

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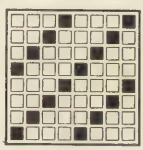

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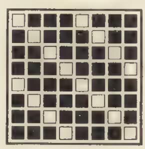

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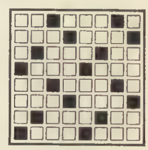

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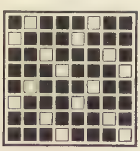

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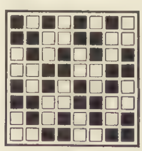

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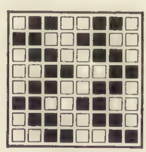

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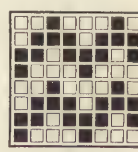

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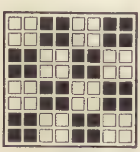

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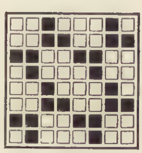

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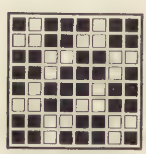

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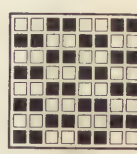

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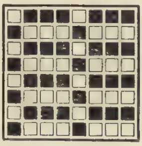
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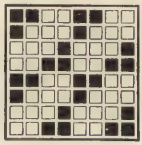
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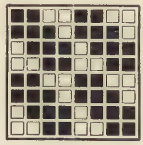
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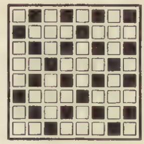
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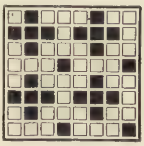
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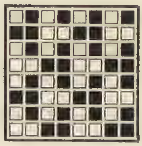
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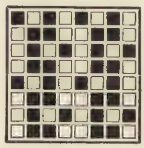
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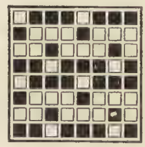
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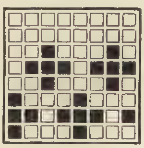
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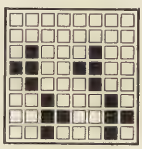
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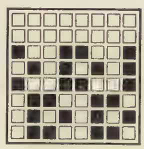
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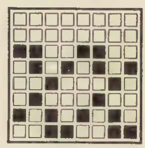
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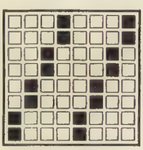
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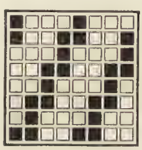
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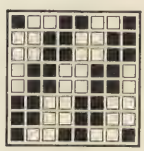
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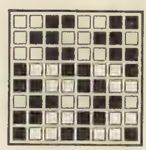
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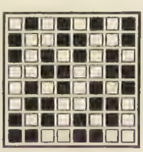
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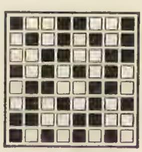
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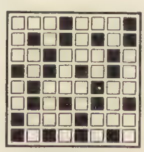
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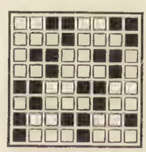
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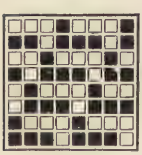
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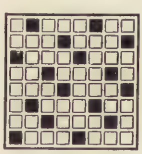
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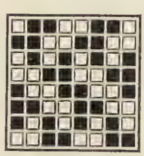
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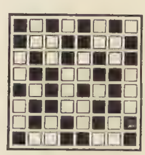
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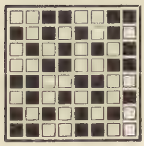

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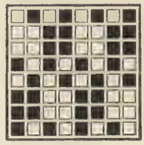

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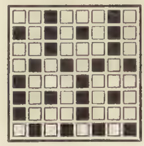

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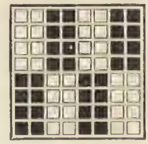

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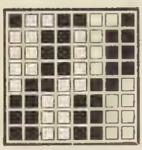

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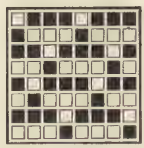

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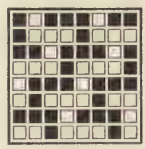

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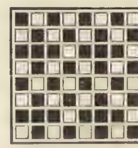

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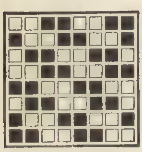

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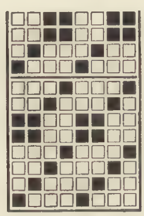

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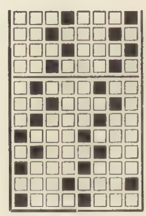

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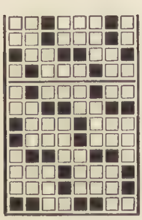

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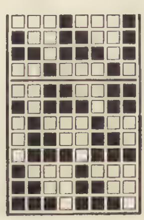

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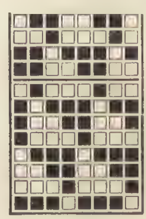

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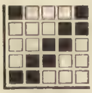
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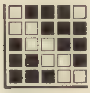
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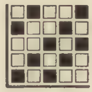
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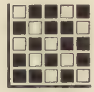
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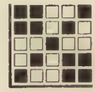
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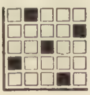
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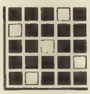
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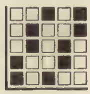
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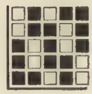
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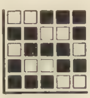
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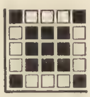
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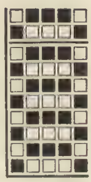
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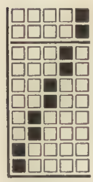
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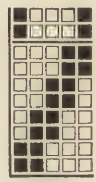
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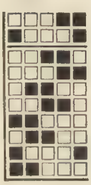
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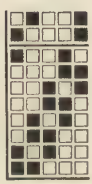
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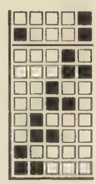
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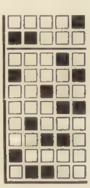
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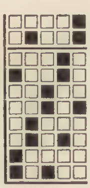
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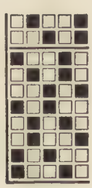
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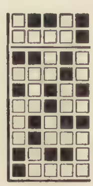
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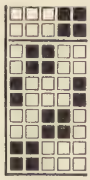
WEAVES COMPLETE ON 5 ENDS—(Continued)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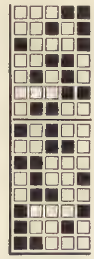
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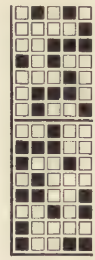
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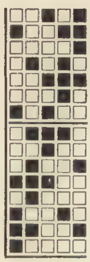
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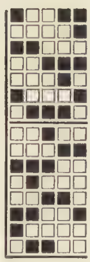
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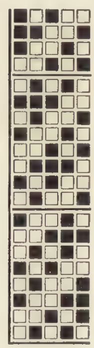
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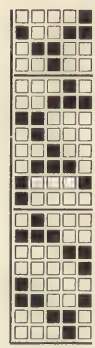
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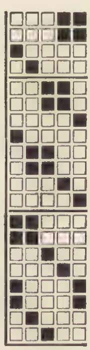
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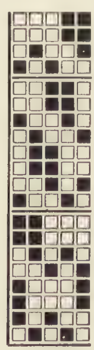
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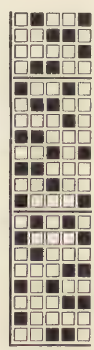
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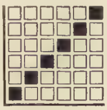
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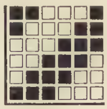
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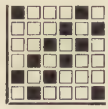
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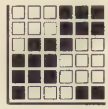
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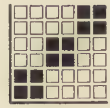
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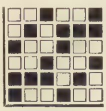
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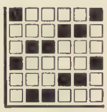
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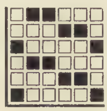
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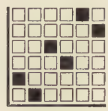
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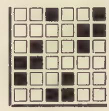
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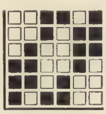
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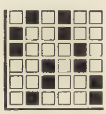
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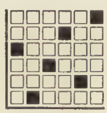
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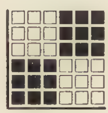
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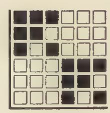
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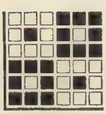
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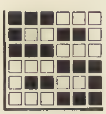
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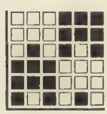
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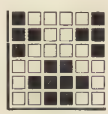
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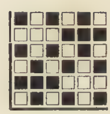
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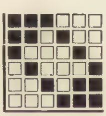
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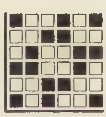
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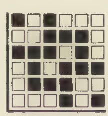
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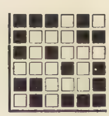
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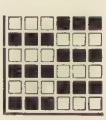
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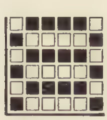
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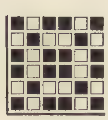
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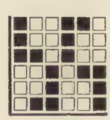
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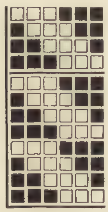
WEAVES COMPLETE ON 6 ENDS—(Continued)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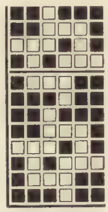
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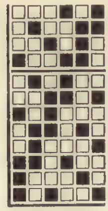
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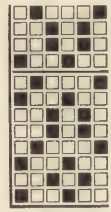
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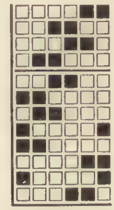
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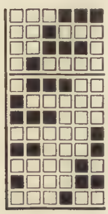
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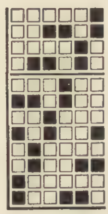
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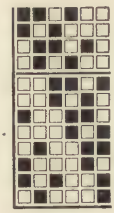
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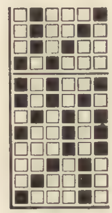
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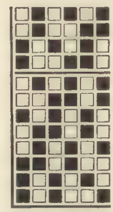
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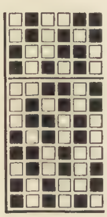
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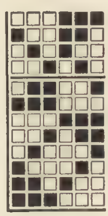
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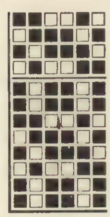
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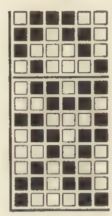
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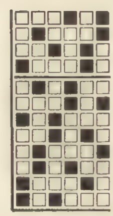
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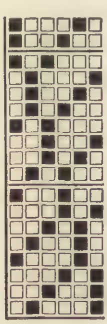
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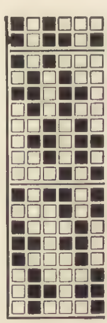
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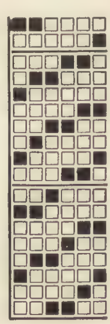
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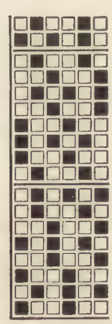
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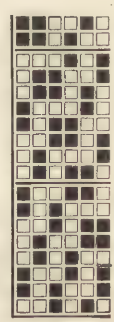
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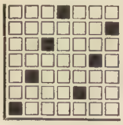
WEAVES COMPLETE ON 7 ENDS



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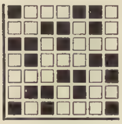

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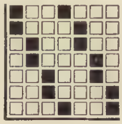

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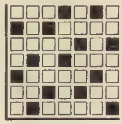

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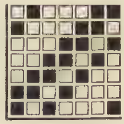

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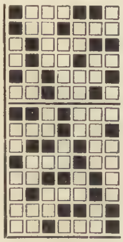

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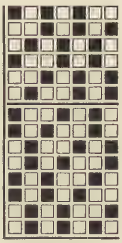

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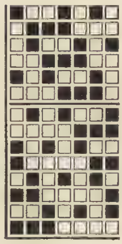

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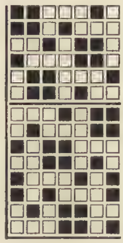

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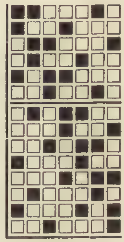

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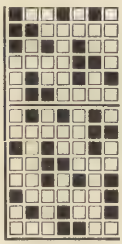

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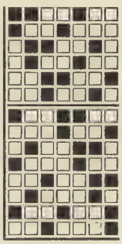

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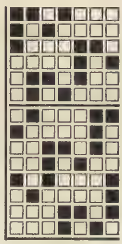

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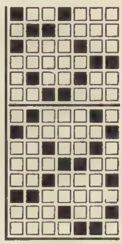

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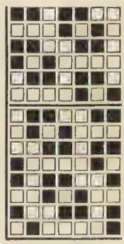

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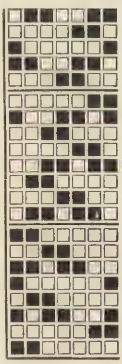

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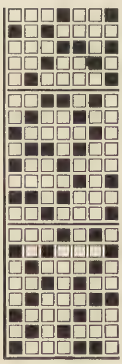

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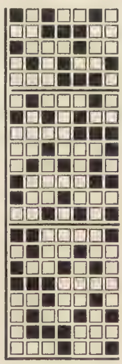

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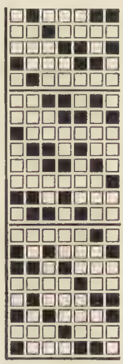

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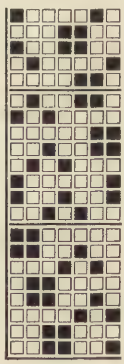
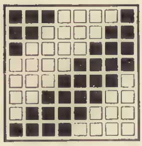


183

WEAVES COMPLETE ON 8 ENDS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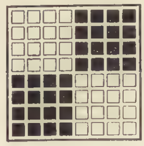
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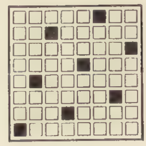
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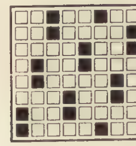
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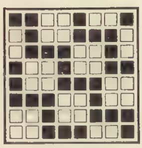
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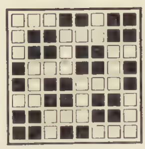
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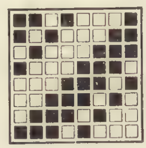
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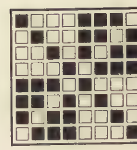
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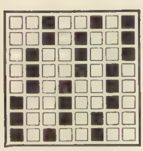
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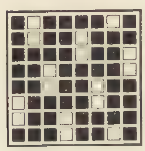
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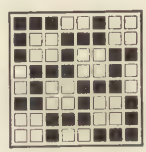
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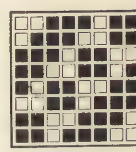
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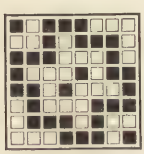
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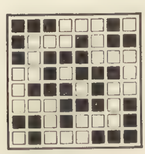
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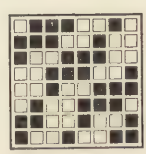
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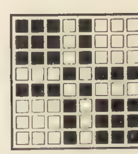
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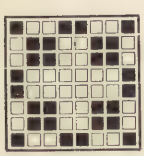
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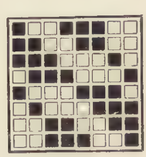
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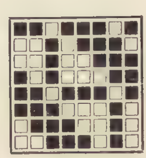
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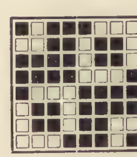
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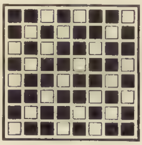
WEAVES COMPLETE ON 8 ENDS—(Continued)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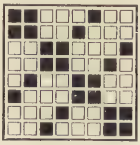
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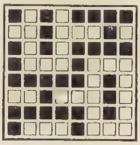
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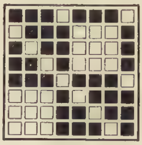
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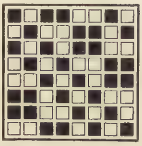
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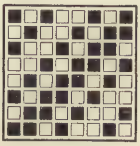
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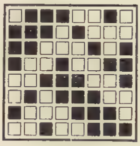
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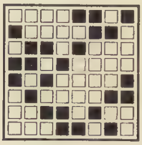
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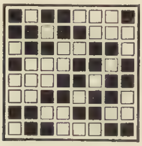
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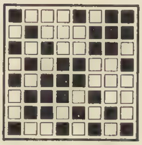
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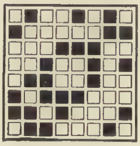
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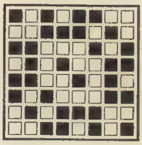
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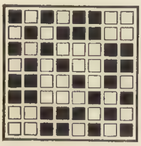
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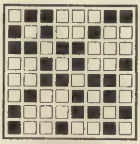
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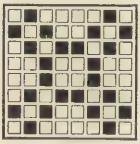
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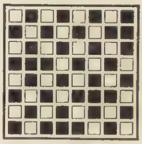
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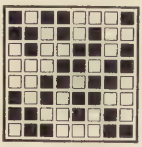
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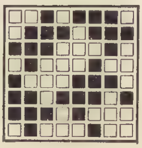
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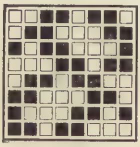
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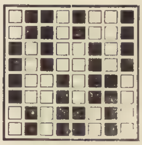
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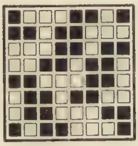
WEAVES COMPLETE ON 8 ENDS—(Continued)



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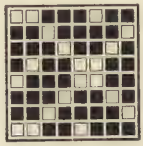

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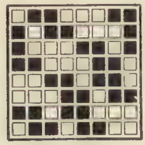

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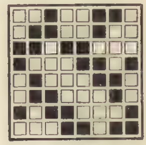

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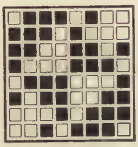

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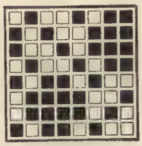

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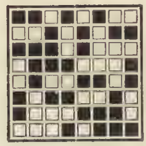

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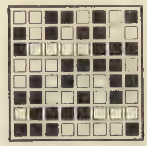

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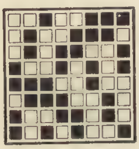

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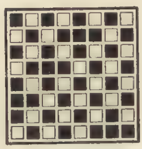

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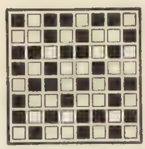

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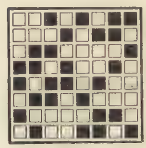

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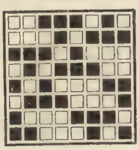

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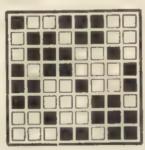

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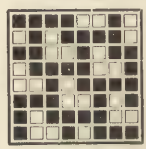

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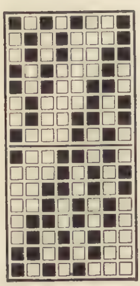

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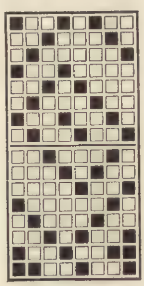

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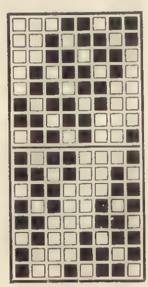

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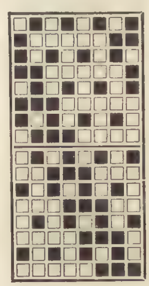

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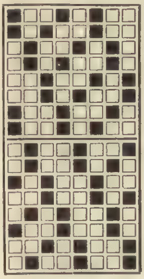
WEAVES COMPLETE ON 8 ENDS—(Continued)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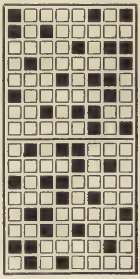
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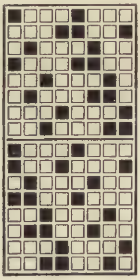
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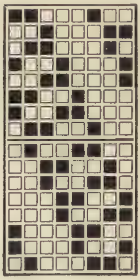
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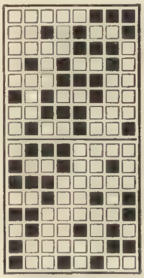
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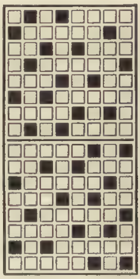
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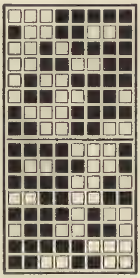
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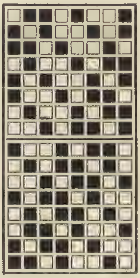
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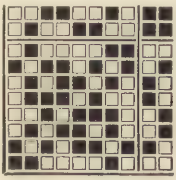
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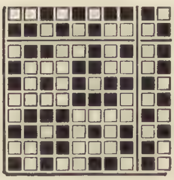
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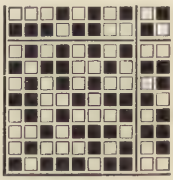
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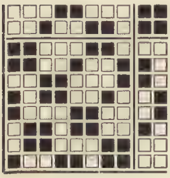
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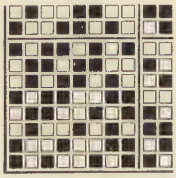
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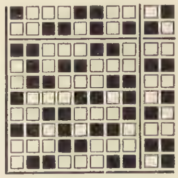
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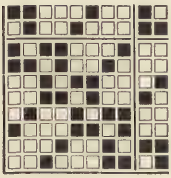
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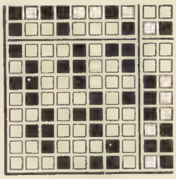
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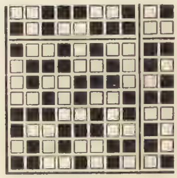
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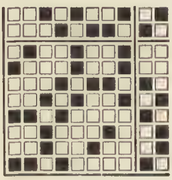
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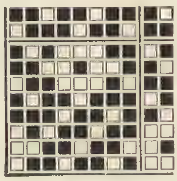
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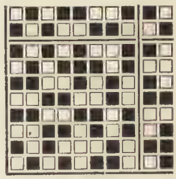
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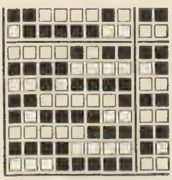
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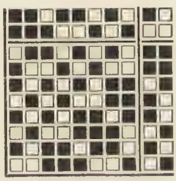
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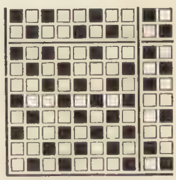
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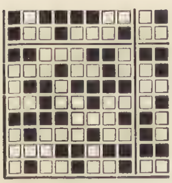
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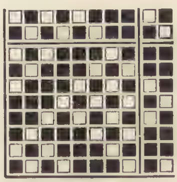
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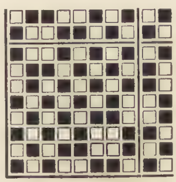
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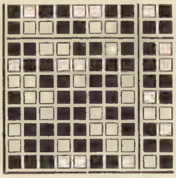
WEAVES COMPLETE ON 10 ENDS—(Continued)



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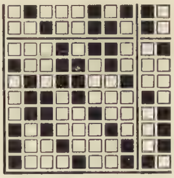

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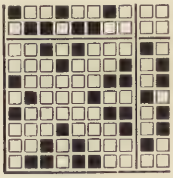

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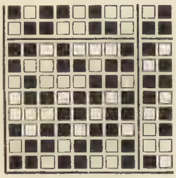

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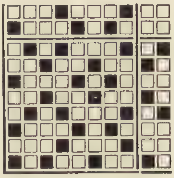

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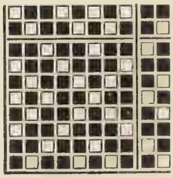

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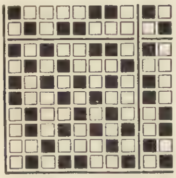

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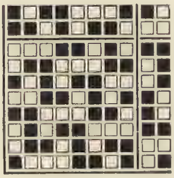

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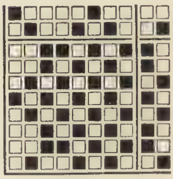

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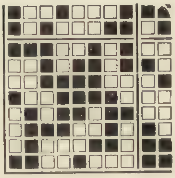

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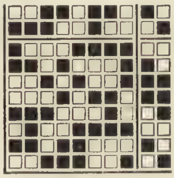

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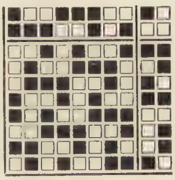

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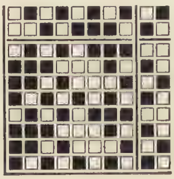

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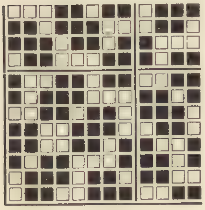
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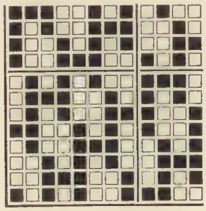
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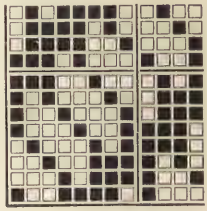
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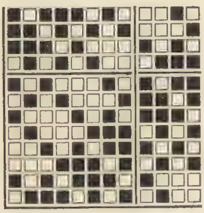
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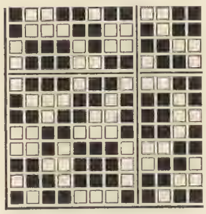
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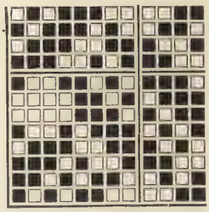
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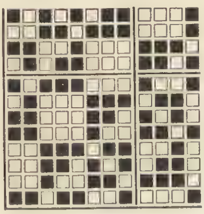
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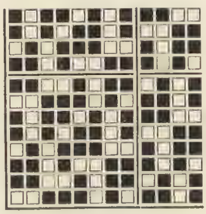
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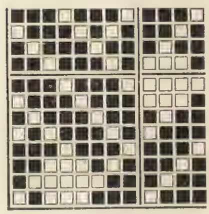
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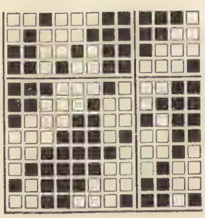
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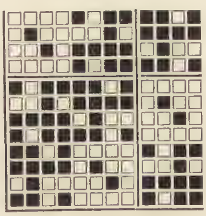
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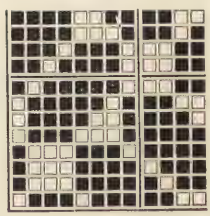
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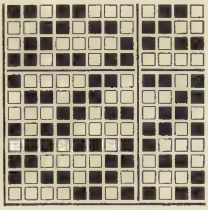
WEAVES COMPLETE ON 12 ENDS—(Continued)



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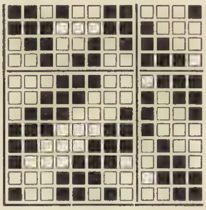

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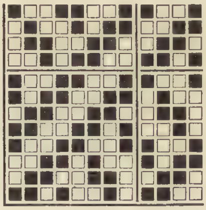

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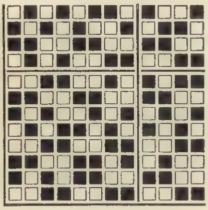

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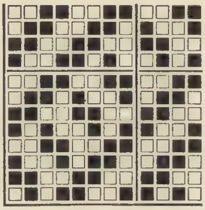

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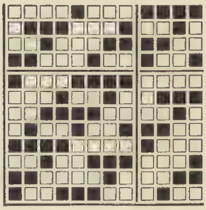

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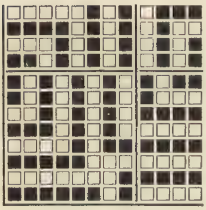

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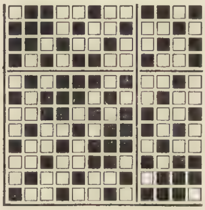

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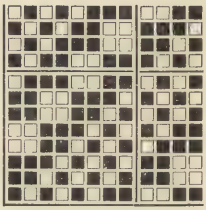

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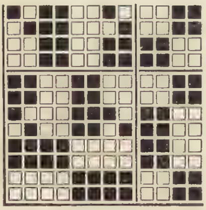

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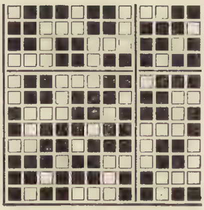

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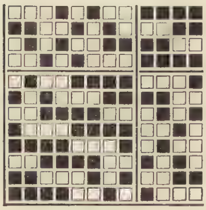

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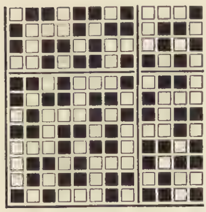
WEAVES COMPLETE ON 12 ENDS—(Continued)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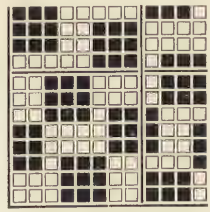
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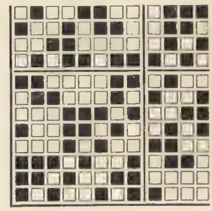
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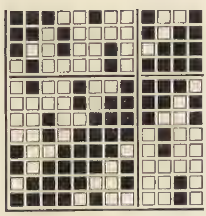
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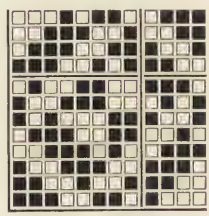
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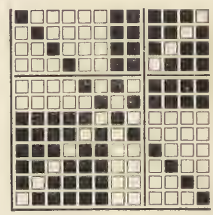
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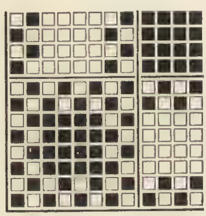
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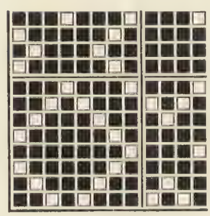
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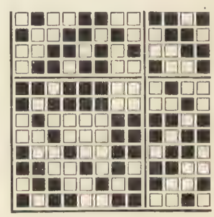
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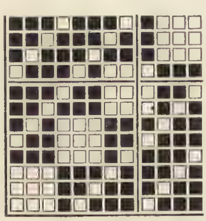
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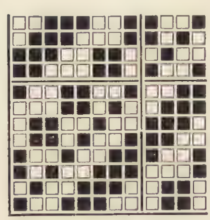
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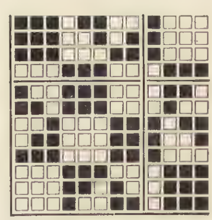
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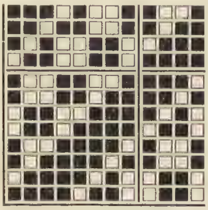
WEAVES COMPLETE ON 12 ENDS—(Continued)



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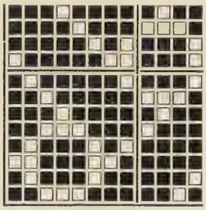

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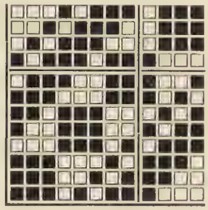

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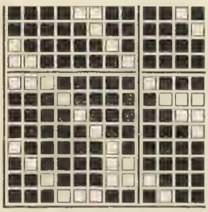

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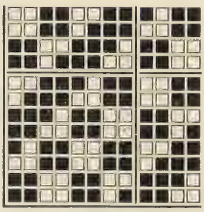

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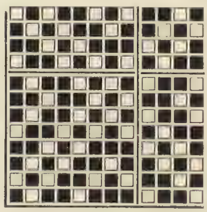

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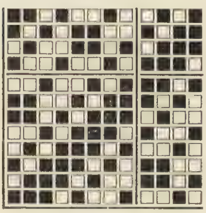

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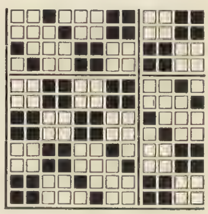

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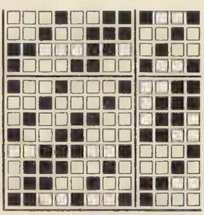

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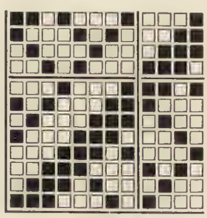

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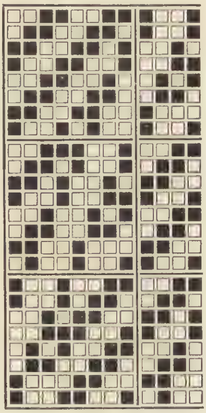
WEAVES COMPLETE ON 12 ENDS—(Continued)



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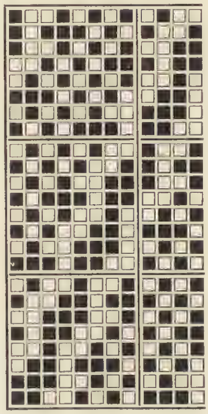

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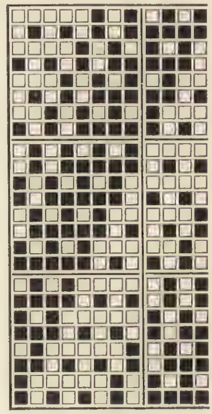

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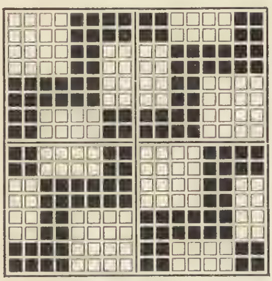

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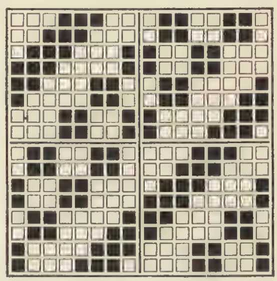

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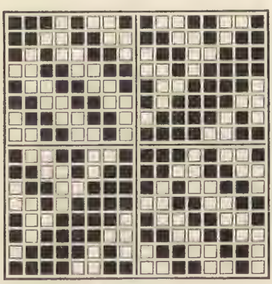

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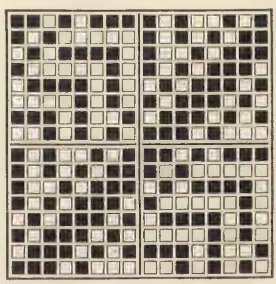

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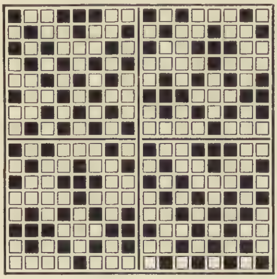
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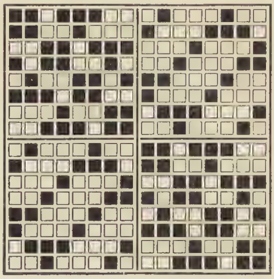
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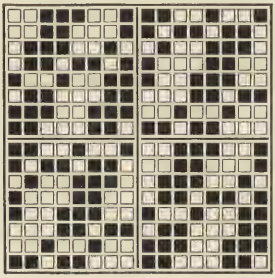
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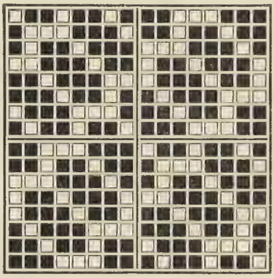
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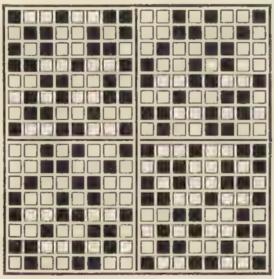
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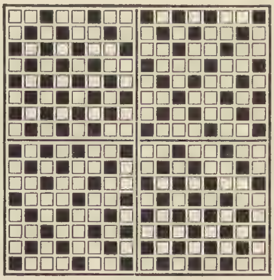
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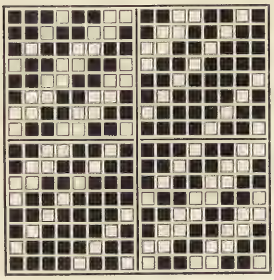
WEAVES COMPLETE ON 16 ENDS—(Continued)



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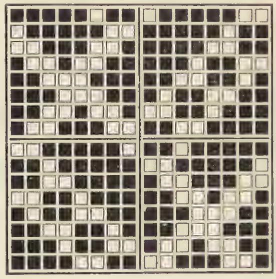

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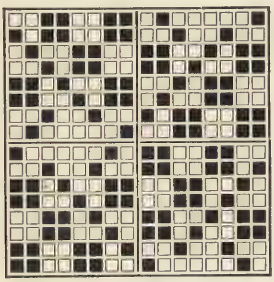

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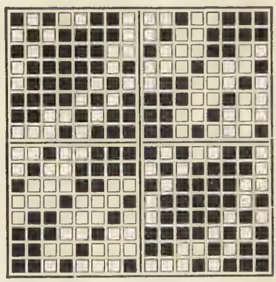

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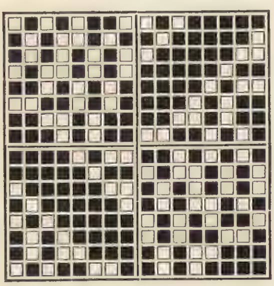

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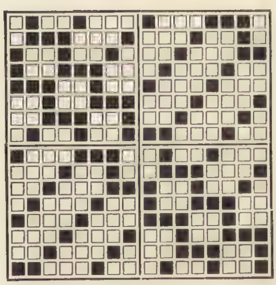

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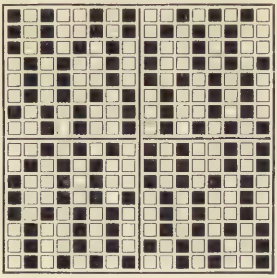

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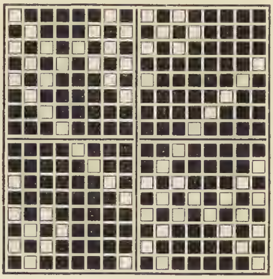

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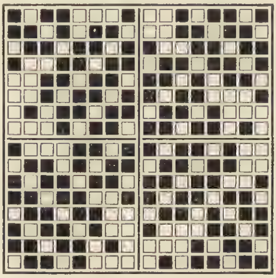

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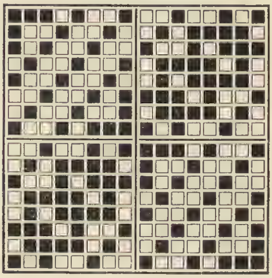

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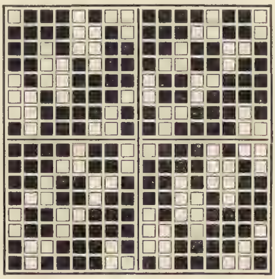

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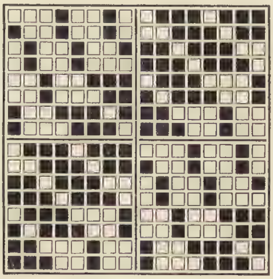

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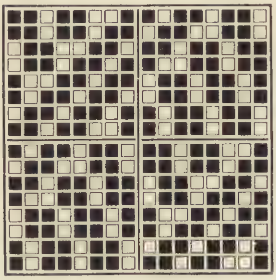

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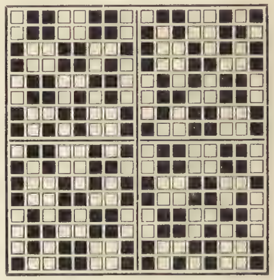

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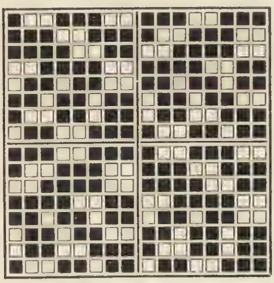

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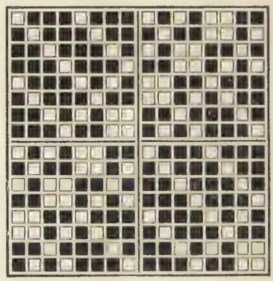

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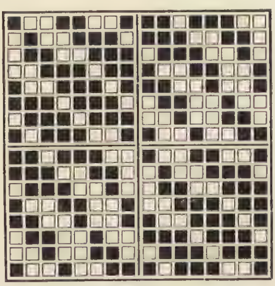

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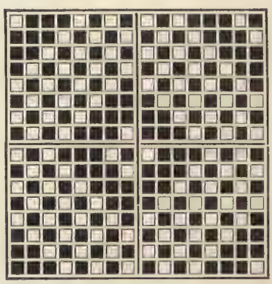

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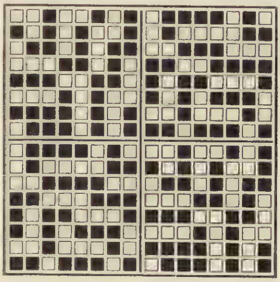
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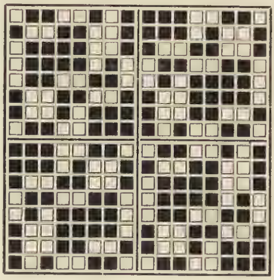
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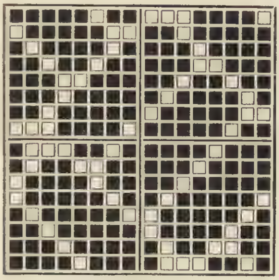
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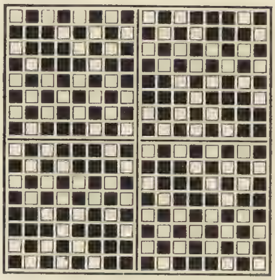
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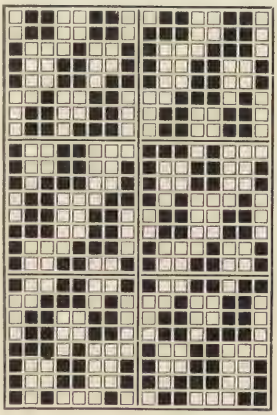
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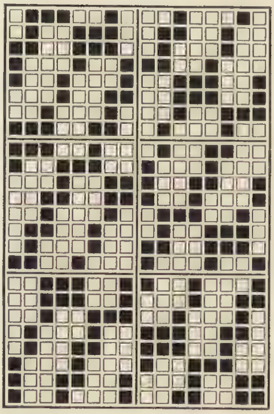
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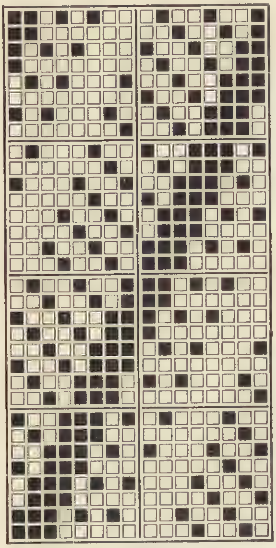

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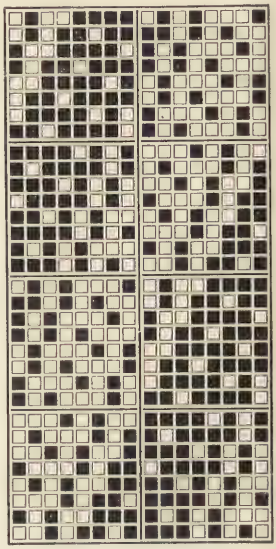

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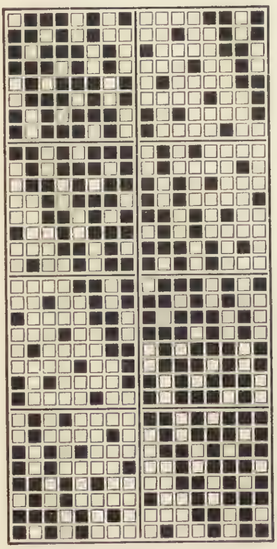

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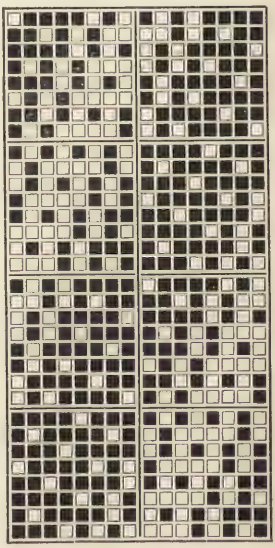

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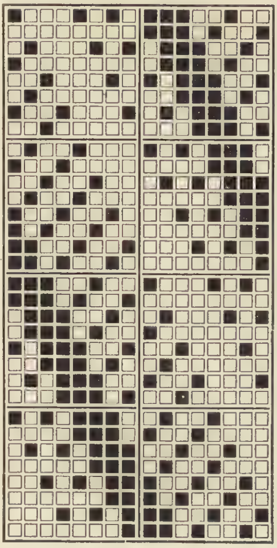

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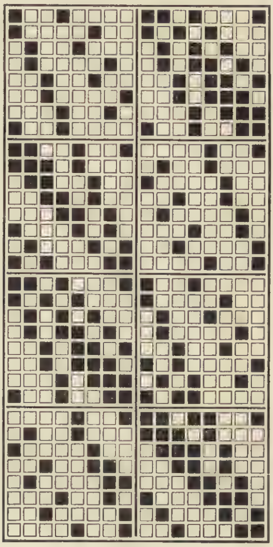

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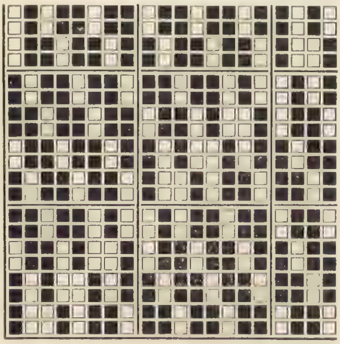

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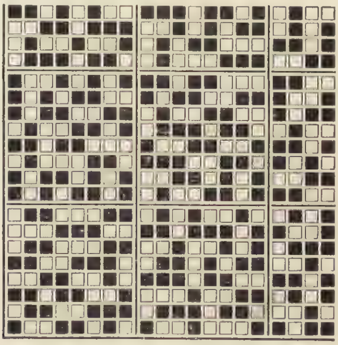

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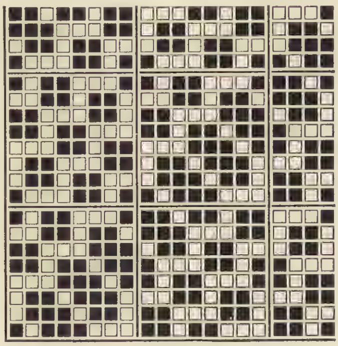

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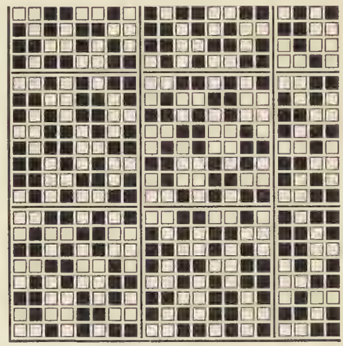

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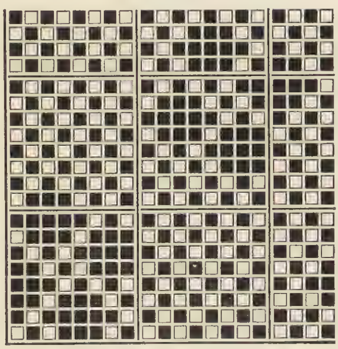

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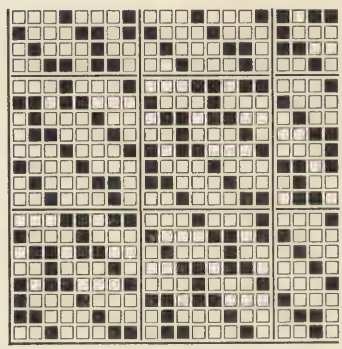

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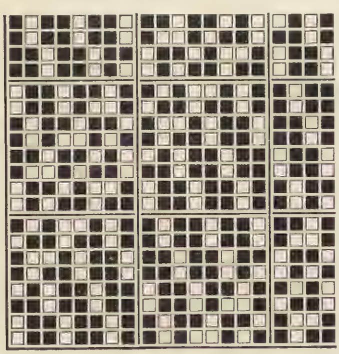

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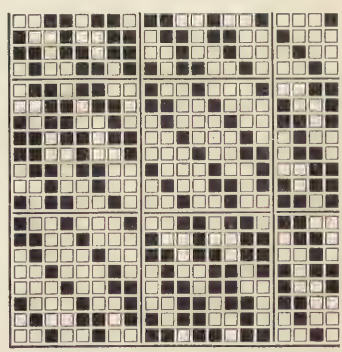

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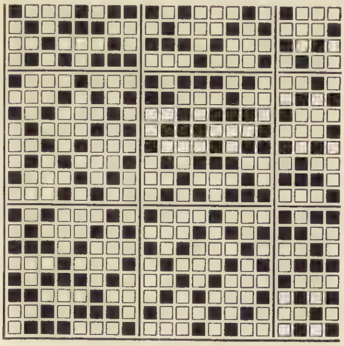

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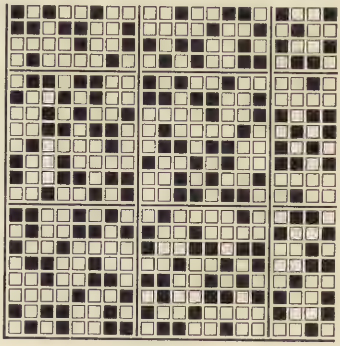

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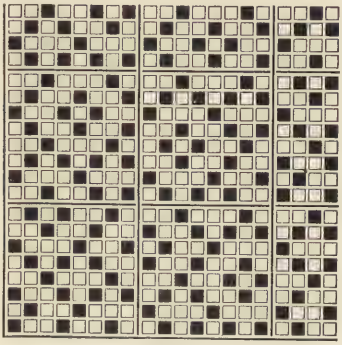

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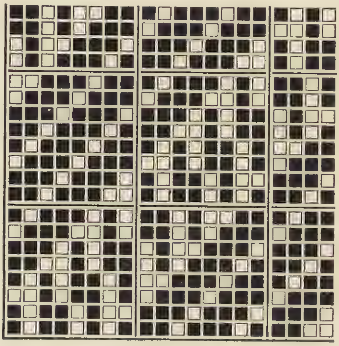

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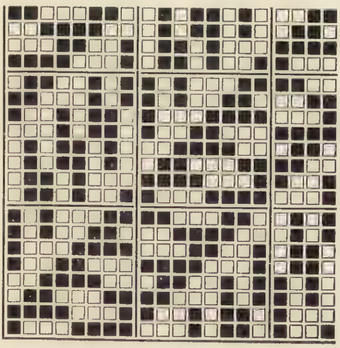

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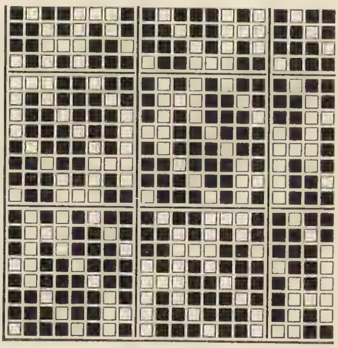

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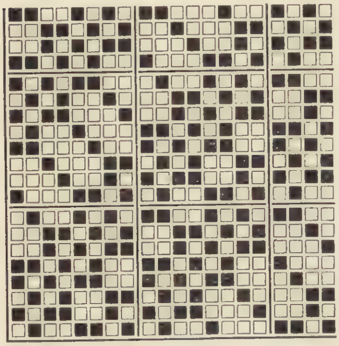

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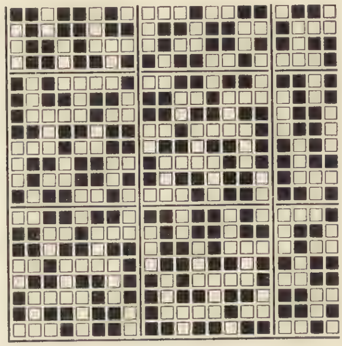

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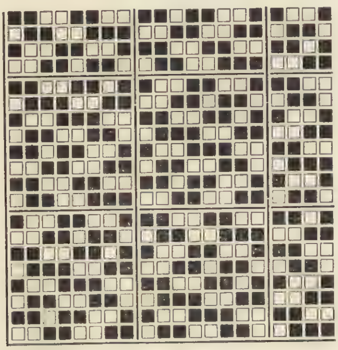

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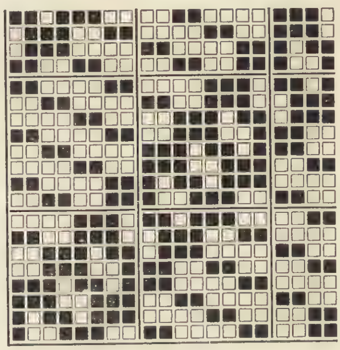

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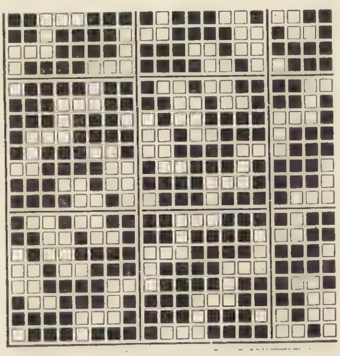

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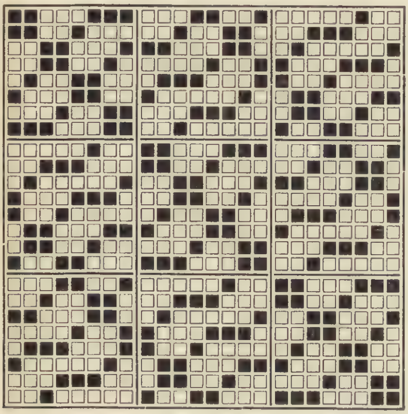

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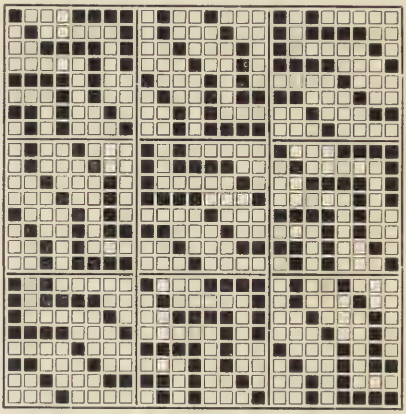

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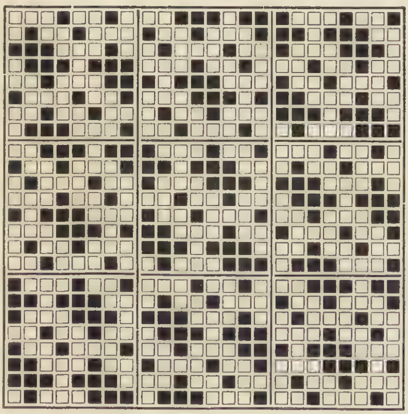

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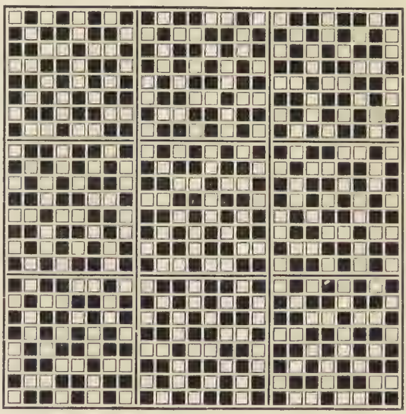

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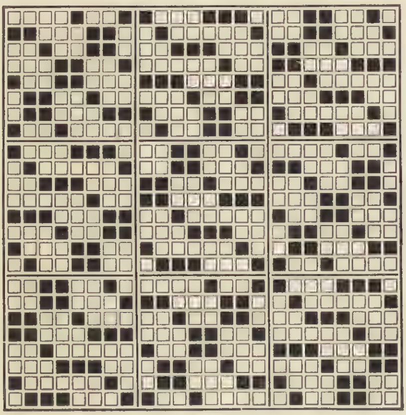

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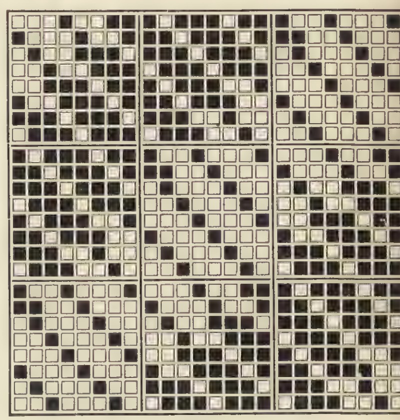

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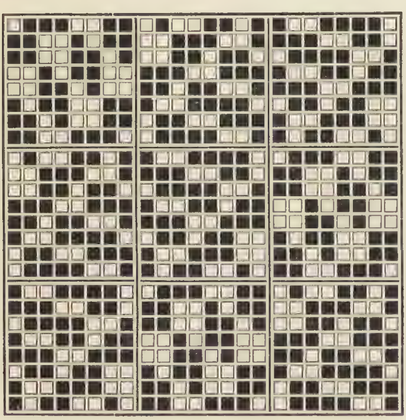

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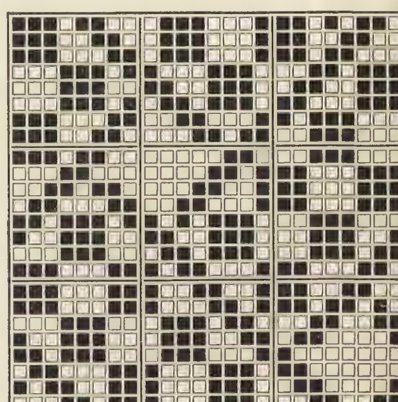

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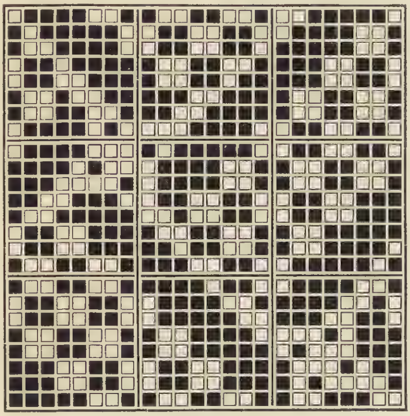
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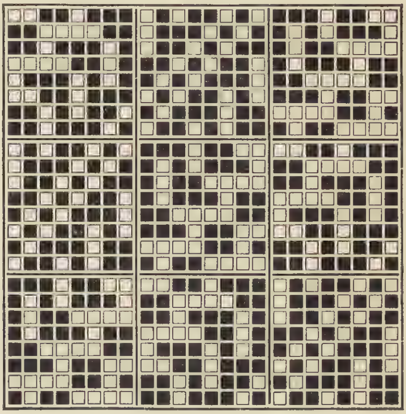
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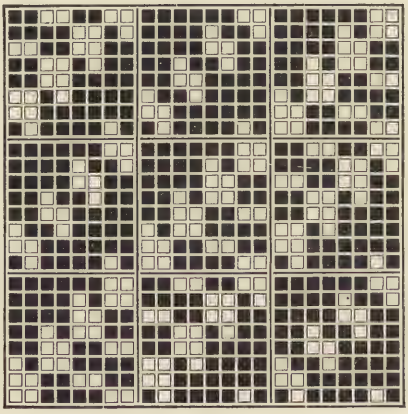
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ELEMENTARY TEXTILE DESIGNING

FUNDAMENTAL PRINCIPLES OF DESIGNING

INTRODUCTION

1. In the manufacture of textile fabrics, other than plain, standard goods, no branch of the business is more important than that of **designing,** nor does anything affect the desirability and selling qualities of a fabric more than the design. The material may be costly, the yarn perfect, and the weaving and finishing well executed, but if the design is not well conceived, or is not adapted to the purpose for which the cloth is intended, the fabric will be inferior. The designing of a textile fabric is an operation peculiar to itself and somewhat foreign to the general conception of the term designing, in that the actual construction of the fabric must be considered in order to obtain the desired effect, or design, on its face. In order that the best methods of manufacturing any class of goods may be intelligently understood, it is first of all essential to acquire a thorough knowledge of woven fabrics, since if the results obtained, or in other words the finished cloths, are not understood, it is unreasonable to suppose that the reasons for the processes through which the yarns pass before becoming cloth can be intelligently comprehended. The person who can take a small sample of cloth and reproduce it in the loom or who can originate a

design of merit with only the necessary yarns and mechanisms with which to work, even if this work is not in his direct line, has a great advantage over a person who cannot. Designing may be said to be as old as weaving, since no cloth can be produced unless the manner in which the ends are drawn through the harnesses, the order of raising the harnesses, and the order of interlacing these ends with the filling are known.

Cloth analysis, or the process of finding the method of construction employed in a fabric, and designing, which strictly speaking, is the process of originating new fabrics, are studies that are closely allied, and the benefit derived from a close study of the structure of the various fabrics frequently met with cannot be overestimated.

WEAVE

2. Construction of Fabrics.—All woven fabrics are constructed of two series of yarns; namely, the *warp*, which is the system of parallel threads running lengthwise of the goods, and the *filling*, which is the system of parallel threads running across the cloth at right angles to the warp. A single thread of the warp is known as a *warp end*, or simply an *end*, and a single thread of the filling is known as a *pick*. By the weaving process the picks of the filling are interlaced with the ends of the warp so as to produce a woven fabric of a texture depending, to a great extent, on the method of interlacing.

3. Plain Weave.—The simplest method of interlacing the warp and filling is by that system known as *plain weave*. Fig. 1 is a diagrammatic view of a plain woven fabric, in which the threads shown in a vertical position are the warp ends, while those running from side to side are the picks of filling. If this diagram is examined closely, it will be noticed that one pick of filling is over all the odd-numbered ends of the warp and under all the even-numbered ends, while the next pick of filling interlaces with the warp ends in reverse order. This method of interlacing the warp and

filling is the simplest that can be devised, and is therefore called the **plain weave.**

It should be understood, however, that the interlacing of the warp and filling is not the same in all cloths; in fact, it is by changing the manner of this interlacing that different effects are formed.

4. Design Paper.—Since there are many methods of interlacing the warp and filling, some system must be employed to represent these methods, or *weaves*, on paper.

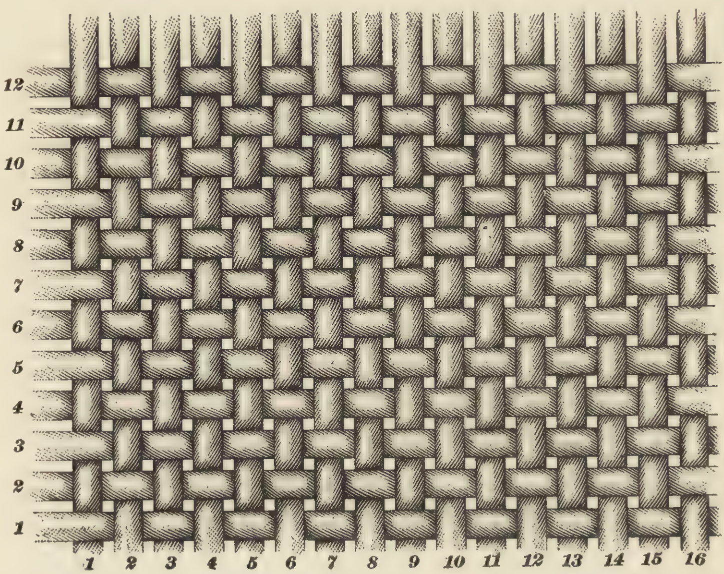


FIG. 1

The one universally used employs an especially ruled paper, shown in Fig. 2, known as **design paper.** It is made in several styles but the kind commonly used is shown at (*a*); the others are used in special cases. The common form of design paper is divided by heavy lines into blocks of eight rows of squares each way. Each vertical row of squares of the design paper represents a warp end, and each horizontal row, that is, those that run from side to side, represents a pick of filling. It should be thoroughly understood that it

is not the lines but the rows of squares enclosed by these lines that represent the ends and picks; thus in Fig. 2 (*a*) there are 8 ends and 8 picks represented in each part marked

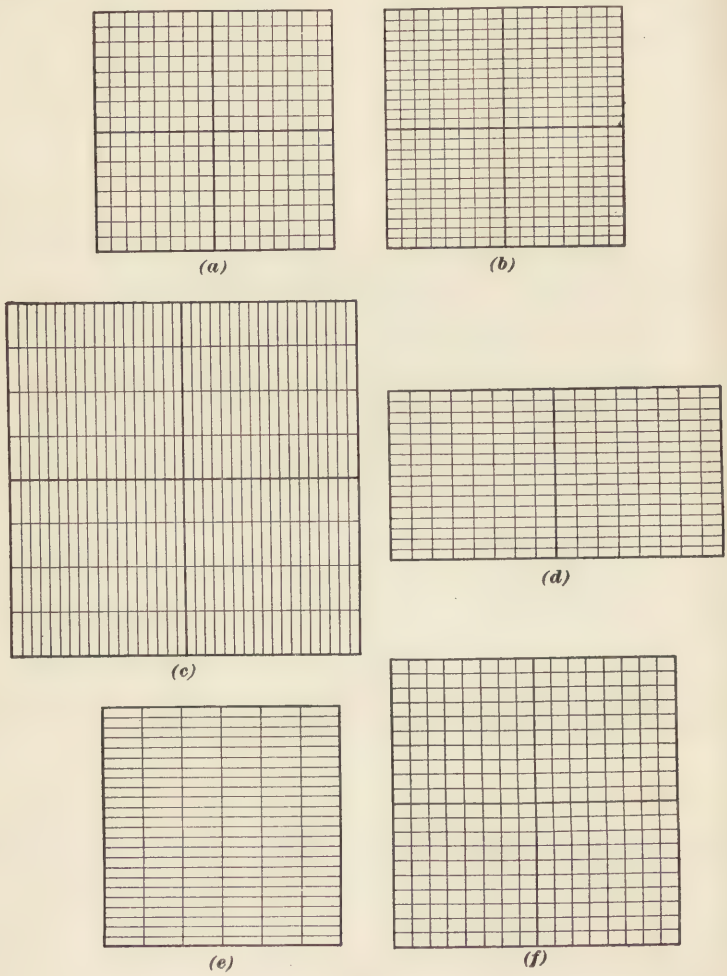


FIG. 2

off by the heavy lines. This is the method of designating different design paper; that is, by giving the number of ends and picks that are shown in the square marked off by the

heavy lines. In speaking of design paper the number of ends represented is always given first, followed by the number of picks represented. Thus (*a*) is called 8×8 design paper; (*b*) is 8×12; (*c*) is 18×4; (*d*) is 8×16; (*e*) is 6×24; and (*f*) is 8×10.

METHOD OF INDICATING A WEAVE ON DESIGN PAPER

5. The interlacing of the warp and filling, or the weave, is indicated by marking or filling in certain squares of the design paper while others are left blank. When a square is marked, it indicates that the warp end represented by that vertical row of squares is lifted at that point and that the pick of filling represented by the horizontal row of squares is underneath the warp end; for instance, if the square on the first end and first pick is marked, it indicates that the first end is raised over the first pick. When a square is left blank, it indicates that the warp end represented by that vertical row of squares is lowered at that point and that the pick of filling represented by that horizontal row of squares is over the warp end; for instance, if the square on the first end and first pick is left blank it indicates that the first end is lowered under the first pick. The fact that marked squares always mean warp up and blank squares filling up, should be firmly fixed in mind.

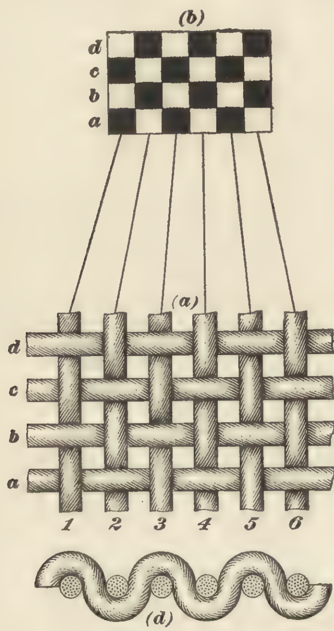
The warp ends are drawn through harnesses, so that when a harness is raised the warp ends drawn through it are raised and lifted over the filling; whereas, when a harness is lowered the warp ends drawn through it are depressed under the filling. Consequently, whenever a square on the design paper is filled in, it shows that the harness through which that end is drawn is lifted; and, on the other hand, when a square is left blank, it shows that the harness through which that warp end is drawn is lowered.

6. The representation on design paper of the interlacing of the warp and filling is known as the **weave**. Fig. 3 is a diagrammatic view of a cloth woven with the plain weave and also illustrates the method of representing the weave on design paper. Dealing first with (*a*) and (*b*) only, (*a*) shows

the way the ends and picks of the cloth are interlaced, while (*b*) shows the weave.

It must constantly be borne in mind that each vertical row of squares represents a warp end, while each horizontal row represents a pick of filling. The lines drawn from (*a*) to (*b*) show which warp end each vertical row of squares represents; the ends are numbered *1*, *2*, *3*, *4*, *5*, and *6* at the bottom.

By following the ends from (*a*) to (*b*), it will be seen that when they are up, as shown in (*a*), the corresponding squares in (*b*) are filled in, and on the other hand when the ends are down, the corresponding squares in (*b*) are left blank. Following the first end, it will be noticed that, starting at the bottom of (*a*), this end is over the first pick *a*; therefore, the first square at the bottom of the row of squares representing this end, as shown in (*b*), is filled in. Continuing with this same end, it will be seen that it is under the next pick *b*; therefore, in (*b*) the next square above the one previously marked will be left blank. Still continuing with this end, it will be seen that it is over the next pick *c*; therefore, the next square above in (*b*) is filled in. The end now passes under the next pick *d* in (*a*) and is shown by leaving the corresponding square in (*b*) blank. Following the next end *2* in the same manner, it will be seen that it is under the pick *a*, over *b*, under *c*, and over *d*. If the



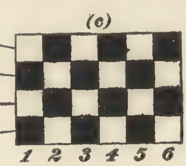


FIG. 3

vertical row of squares, in (*b*), that represents this end is now examined, it will be seen that wherever this end is up, the square is filled in, and wherever it is down, the square is left blank. Thus, the weave is shown in (*b*), and if each end is examined in the same manner it will be seen that the interlacing of each end in (*a*) is correctly shown in (*b*).

It should be noticed that when the interlacings of the warp ends are shown in this manner, the interlacings of the filling must necessarily also be shown, since when a square is filled in it not only shows that the warp end is up at that point but also indicates that the filling at that point is under the warp; and when a square is left blank it not only shows that the warp end is down at that point but also that the filling is over the warp end. Therefore, when the ends have been shown on design paper, the picks also have been shown, and consequently (*b*) shows where the filling is up and where down in the same manner as it shows where the warp is up and where down. That this is so may be seen by referring to (*c*), which is exactly the same as (*b*) except that in this case the lines are drawn from the picks in (*a*) to the rows of squares in (*c*) that represent the respective picks. If the picks are followed from (*a*) to (*c*) in the same manner as the ends were followed from (*a*) to (*b*), it will be seen that (*c*) shows the interlacings of the picks. Therefore, since (*b*) is the same as (*c*), either will show the weave of the cloth equally well.

In Fig. 3, (*d*) is a method of showing the interlacing of one pick of filling with the warp and represents the manner in which either of the picks *b* and *d* interlaces with the warp ends, the curved line showing the pick of filling and the circles, sections of the warp ends. As shown, the pick is over the first and under the second warp end, etc.

7. Another very important point to be noticed in this connection is that every other end is alike and every other pick is alike. By examining Fig. 3 (*a*) it will be seen that the first, third, and fifth ends are alike and also that the ends marked *2*, *4*, and *6* are similar to each other, while the picks marked *a*

and *c* are alike as also *b* and *d*. From this it will be seen that in the case of a plain weave it requires only 2 ends and 2 picks to show the manner in which all the ends and picks interlace. Or, in other words, 2 ends and 2 picks show one *repeat* of the weave, all the other ends and picks being simply repetitions of these 2 ends and 2 picks. Fig. 4 shows one repeat of the plain weave represented on design paper.

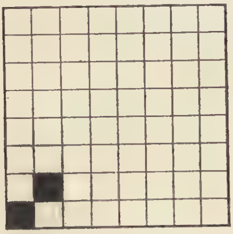
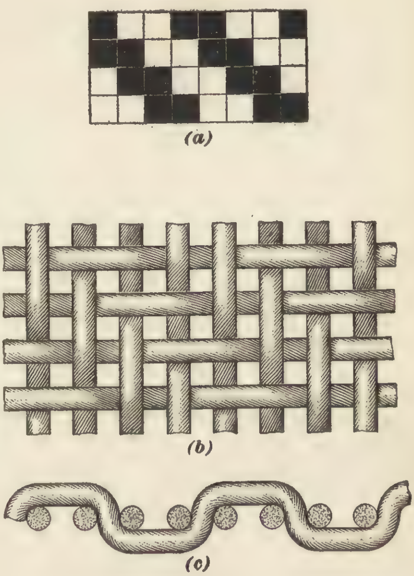


Fig. 4

All weaves repeat on a certain number of ends and picks. It need not necessarily be two ends and two picks, nor is it necessary for the ends to repeat on the same number as the picks, but each must repeat at some time. To illustrate this point further Fig. 5 is given; (*a*) shows a weave on design paper; (*b*) shows the manner in which the ends and picks interlace; and (*c*) shows one of the picks interlacing with the warp ends. If each end in (*b*) is compared with the representation of the corresponding end in (*a*), it will be seen that (*a*) is the weave of (*b*). When speaking of the first end of a weave, the one at the extreme left is always intended, while the first pick is the one at the bottom; the first end and first pick are represented in all cases by the square in the lower left-hand corner. Referring to (*a*), notice carefully the interlacings of each end. It will be seen that the first, second, third, and



(*a*)

(*b*)

(*c*)

Fig. 5

fourth are all different, but that the fifth is like the first, the sixth is like the second, the seventh is like the third, and the eighth is like the fourth. If more ends were shown they would repeat in the same manner; therefore, it will be seen that this weave is complete on 4 ends and that at (*a*) and (*b*) two repeats are shown. If more picks were shown the fifth pick would be like the first, and so on; therefore, the weave is complete on 4 picks. Consequently, one repeat of this weave occupies 4 ends and 4 picks. With every weave, the number of ends and picks that constitutes a repeat should be carefully determined.

HARNESS DRAFT

8. Every end in the warp that interlaces with the filling differently from the others must be drawn through a separate harness in the loom, but every end in the warp that works in a manner similar to some other end may be drawn through the same harness as that other end, provided that it is drawn in its regular order. Thus in the case of the plain weave, if every even-numbered end is drawn through one harness and every odd-numbered end is drawn through another harness and these two harnesses are made to rise and fall alternately, or first one and then the other is lifted, and a pick of filling passed through each opening, cloth similar to that shown in Fig. 1 will be formed.

The method, or order, of drawing each end of a weave through the loom harnesses is usually indicated on design paper by means of a draft, generally called the **harness draft,** but frequently designated as the **drawing-in draft.** This is best indicated with figures, but may be shown by means of crosses, dots, etc. In Fig. 6, (*a*) shows the plain weave extended on 8 ends, while (*b*) shows the harness draft—that is, through which harness each end is drawn. The number over each end in the weave (*a*) indicates the number of the warp end. It will be seen that the first end is drawn through the first harness, as shown in the harness draft (*b*), while the second end, as it interlaces with the filling differently from the first, must be drawn through a separate harness, or

the second, as shown; the third end in the weave works like the first and therefore can be drawn through the same harness as the first end; the fourth end works like the second and is consequently drawn through the same harness as the second. Thus it will be seen that the first end is drawn through the first harness and the next through the second, and that throughout the weave and the warp every alternate end is drawn through the same harness. The harness draft is simply a draft showing the person who draws in the warp ends through which harness each end of the warp is to be drawn, being so constructed that ends having the same interlacings are drawn on the same harness. Harness drafts are generally constructed for only one repeat of the weave, since all other ends are drawn in similarly to the ends in that repeat. Consequently, in making out the harness draft for the plain weave only the first two ends need be shown; therefore, the first two ends in the harness draft, Fig. 6 (*b*), show the manner of drawing in all the ends of the warp.

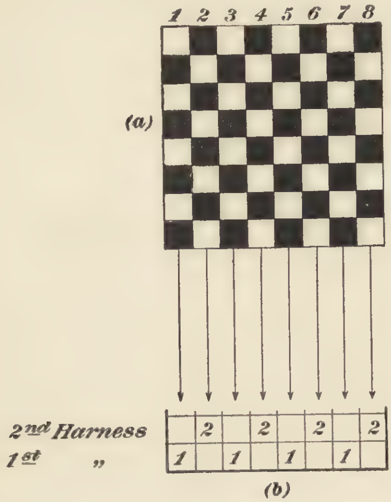


FIG. 6

9. The derivation of the harness draft for the plain weave, although a typical example of the method employed with all weaves, is comparatively simple; hence, to illustrate further this method another example is given in Fig. 7, where (*a*) shows a weave and (*b*) shows the harness

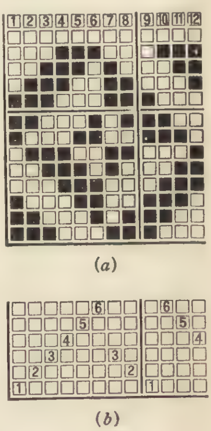


FIG. 7

draft. By noticing the weave it will be seen that the first 6 ends interlace with the filling differently; therefore, they must all be drawn through separate harnesses. This is done in the harness draft (*b*), which shows the first end drawn through the first harness, the second end drawn through the second harness, the third end drawn through the third harness, and so on up to the sixth end, which is drawn through the sixth harness. The seventh end of the weave is like the third and can therefore be drawn through the same harness. One point to be noted is that in making out a harness draft each row of squares running across the paper represents a harness. Therefore, when making out a harness draft, as each end is indicated, the number showing through which harness it is to be drawn must be placed in the horizontal row of squares representing that harness. Thus in this case, the number *3*, which shows that the seventh end is drawn through the third harness, is placed in a square that will represent the seventh end and also the third harness, as shown. Continuing with the ends in the weave, it will be seen that the eighth end is exactly like the second; therefore, it can be drawn through the same harness as the second end, or the second harness, as shown. The ninth end is exactly like the first end; therefore, it is drawn through the same harness as the first end, which is the first harness. The tenth end is like the sixth, the eleventh like the fifth, and the twelfth like the fourth; therefore, the tenth end is drawn through the same harness as the sixth end, which is the sixth harness, the eleventh end through the fifth harness, and the twelfth end through the fourth harness, as shown in the harness draft.

CHAIN DRAFT

10. After the harness draft has been made to show the method of drawing in the warp ends, a plan must be made to show how, or in what order, the harnesses must be lifted so that the ends drawn through them will interlace with the filling according to the desired weave, or in other words a plan showing which harnesses are to be raised and which lowered

on each pick. This plan is known as the **chain draft** and is obtained from the weave and harness draft as follows: Referring to Fig. 6, it will be seen that the first end has been drawn through the first harness and that all the ends working like the first end have been drawn through that harness; so that if the first harness is raised and lowered in the order indicated by the first end of the weave, all the ends drawn through that harness will be raised and lowered in the same manner and will therefore interlace with the filling in the same way. The second end has been drawn through the second harness and also all the ends that work in a manner similar to the second; consequently, if the second harness is raised and lowered in the same order as that indicated by the second end of the weave, all the ends drawn through that harness will interlace with the filling in a similar manner.

The marks and blanks on the first end of the weave, as shown in (*a*), Fig. 6, indicate the manner in which that end is to be raised or lowered; consequently, by raising the harness through which that end is drawn, or the first harness, in the same manner as the first end is raised, all the ends drawn through that harness will be raised and lowered in their proper order. The marks and blanks on the second end of the weave indicate the manner in which that end must be raised and lowered; consequently, by raising the harness through which that end is drawn, or the second harness, in the same manner as the second end is raised, all the ends drawn through that harness will be raised and lowered in their proper order. This includes all the ends in the warp that work differently, and consequently two harnesses are all that are necessary to produce this weave.

The manner of lifting and lowering the harnesses, or in other words the chain draft, is indicated on design paper by means of blank and filled-in squares, each filled-in square indicating that a harness is raised, while each blank square shows that a harness is lowered. To make a chain draft from the weave and harness draft, commence with the first end and copy the interlacings of each end in one repeat of the weave that is drawn in through a separate harness as indicated by

the harness draft, placing these interlacings of the ends in the same relative position that the harnesses through which they are drawn occupy.

Fig. 4 shows one repeat of the weave shown by the diagram Fig. 1, and since the first end is drawn through the first harness, the interlacings of the first end must be copied to show the manner in which this harness should be raised and lowered. The second end is drawn through the second harness; therefore, to show the workings of this harness the interlacings of this end, as shown in Fig. 4, must be copied. When this has been done it will be noticed that the chain draft is similar to the weave as shown in Fig. 4; therefore, this figure can be used to indicate the chain draft as well as to show the weave.

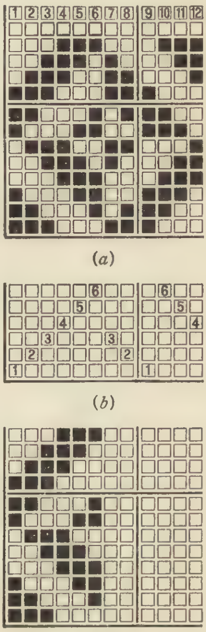


FIG. 8

11. To illustrate further the method of obtaining the chain draft from the weave and harness draft, a chain draft is made for the weave and harness draft shown in Fig. 7. In Fig. 8, (*a*) represents one repeat of the weave; (*b*) shows the harness, or drawing-in, draft; and (*c*) shows the chain draft. The significance of the rows of squares in each figure should be carefully noted. In (*a*), each vertical row of squares represents one end; each row of squares across the design paper, one pick; and each filled square, an end raised over a pick. In (*b*), each vertical row of squares represents one end, the same as in (*a*), but each row of squares across the design paper represents one harness, and each number the harness through which that particular end is drawn. In (*c*), each vertical row of squares represents the working of one harness, or in other words the order of raising and lowering the harness, while each row across the design paper represents one pick, or

one bar of the chain that is placed on the loom to govern the operation of the harnesses.

To make a chain draft from a weave it is simply necessary to copy the interlacings of those ends that are drawn on separate harnesses. Therefore, in order to ascertain the number of ends that any chain draft will require it is only necessary to find the number of harnesses that the drawing-in draft occupies. By referring to Fig. 8 (*b*), it will be seen that 6 harnesses are used, and thus only six vertical rows of squares, representing the 6 ends of the weave that have different interlacings, will be required for the chain draft. In copying the interlacings of those ends that are drawn on separate harnesses, since the first end is drawn through the first harness, the first harness shown in (*c*) is marked the same as the first end shown in (*a*). The second end is drawn through the second harness, and consequently the second harness shown in (*c*) is marked the same as the second end shown in (*a*). This method is continued with the first 6 ends, all of which are drawn through separate harnesses. The seventh end of the weave is drawn through the third harness, but since the working of this harness has already been set down, it must not be marked again. The same can be said of the rest of the ends, all of which work in a manner similar to some one of the first 6 ends. Therefore, the chain draft is complete as shown in (*c*).

12. The expression **chain draft** is derived from the harness chain used on a woolen or worsted loom, which consists of bars on which rollers, or *risers*, and washers, or *sinkers*, are placed, each bar selecting the harnesses to be raised for 1 pick. With most woolen and worsted looms a roller raises the harness and a sinker causes it to be lowered; thus, wherever a mark is placed in a square of the chain draft, a riser is placed on the harness chain, which will cause that harness to be raised, and wherever a blank square is left in the chain draft, a sinker is placed on the harness chain, which will cause that harness to remain down. The construction of some woolen and worsted looms is such that

the reverse of this statement is true (namely, a roller on the harness chain lowers the harness, while a washer causes it to be raised), so that a mark on the chain draft indicates a washer on the harness chain and a blank square a roller.

The term **pegging plan** is also often used for chain draft, because the pattern chain commonly used on a cotton dobby loom consists of wooden bars into which pegs are inserted. When a square is marked on the chain draft, a peg is inserted in the bar and the harness is raised; when the square is blank, the bar has no peg and the harness remains down.

EXAMPLES FOR PRACTICE

1. Give the drawing-in draft for Fig. 9.

2. Give the chain draft for Fig. 9 to correspond with the drawing-in draft shown in answer to question 1.

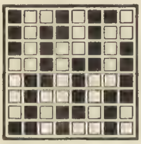
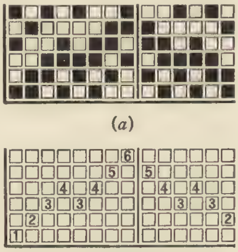


FIG. 9



(a)

(b)

FIG. 10

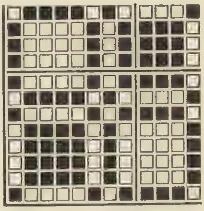


FIG. 11

3. Fig. 10 (*a*) and (*b*) shows a weave and drawing-in draft; give the chain draft to correspond with the drawing-in draft.

4. Give the drawing-in draft for the weave shown in Fig. 11, placing all ends that work alike on the same harness.

5. Give the chain draft for Fig. 11 to correspond with the drawing-in draft shown in answer to question 4.

THE EFFECT OF THE WEAVE

13. The weave, harness draft, and chain draft have thus far been explained in connection with specific cases, but these subjects will now be dealt with in a more general way. The weave may be said to influence the build of the fabric; for instance, if the interlacings of the different ends are not equally balanced, that is, if all the ends in one repeat of the weave do not interlace about the same number of times, it will be impossible to obtain a regular and uniform cloth. Fig. 12 shows a weave that will serve to illustrate this point. By examining this weave it will be noticed that the first, second, seventh, and eighth ends make twelve interlacings, while the remaining ends make only four interlacings in one repeat of the weave. A warp end is said to interlace, or to make one interlacing, each time that it passes through the cloth from the face to the back or from the back to the face; that is, an interlacing is made each time that the warp end is raised over, or depressed under, one or more picks. In the same way a pick is said to make an interlacing each time that it passes over or under one or more warp ends. Those ends and picks that make the greater number of interlacings will naturally be woven tighter than those that make fewer interlacings; therefore, with such a weave as is shown in Fig. 12 it is not possible to produce a level cloth. This weave is known as a *honeycomb*, and a level cloth is not desired but rather one with a honeycombed effect.

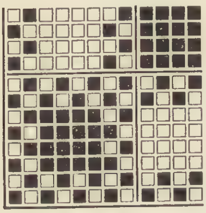


FIG. 12

The number of interlacings in a weave affects the length of warp required to weave a given length of cloth. For example, if cloths having the same number of picks per inch and the same counts of yarn were woven with the weaves shown in Figs. 3 and 5, the cloth made with the weave in Fig. 3 would require a longer warp than that woven with the weave shown in Fig. 5, if the same number of yards of each cloth were desired. This may be demonstrated by taking a

piece of thread and interlacing it two or three times between the fingers of one hand, having the thread pass over one finger, under the next, over the next, and so on, noting the length of thread that is taken up, and afterwards passing the thread back and forth again the same number of times but having it pass over two fingers and under two fingers, when the difference in the lengths required in the two operations may be noticed. It will be found that the length of the thread increases with the interlacings. It is exactly the same principle that necessitates a longer warp when there are more interlacings of the ends and picks. The interlacings also affect the number of ends and picks that can be placed in 1 inch of the cloth; the general rule being that the greater the number of interlacings, the smaller is the number of ends or picks that can be crowded together.

The weave also affects the appearance of the cloth, since it is possible to produce a great many patterns in woven fabrics by simply changing the method of interlacing the warp and filling, no variety of colors or yarns being needed. Again, a weave may be used in a figured design that will influence the development of the details of the pattern; for instance, it may be desired to have a certain effect or to bring certain colors to the face of the cloth in some parts of the design.

STANDARD TYPES OF HARNESS DRAFTS

14. Straight Drafts.—The simplest method of drawing the warp ends through the harnesses is that employed with the plain weave. As previously explained, in this weave there are only 2 ends in one repeat of the weave and they are drawn through 2 harnesses, first an end through one harness and then the next end through the other harness, and so on. This method of drawing in the warp ends is a standard method and is known as the *straight draft.* A **straight draft** is not confined to 2 harnesses, but may be defined as a draft in which the ends are drawn through the harnesses in regular order from front to back. To illustrate this, suppose that a weave occupied 10 harnesses instead of 2 harnesses and that the

ends were drawn straight from the front harness to the back harness. Then the first end would be drawn through the first harness, the second end through the second harness, the third end through the third harness, and so on, ending with the tenth end, which would be drawn through the tenth harness. The draft would then commence another repeat with the first harness again, and the next, or eleventh, end would be drawn through that harness, the twelfth end would be drawn through the second harness, and so on. The harness draft is repeated in this manner until all the ends in the warp have been drawn in. It will be noted here that when the

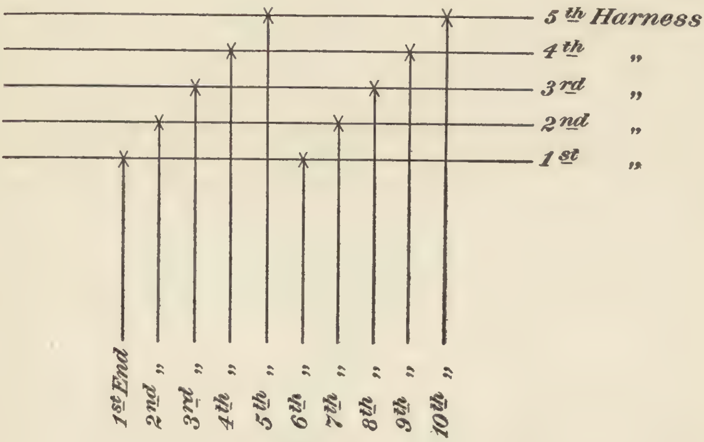


Fig. 13

warp is actually being drawn through the harnesses it is more convenient to read the drawing-in draft in reverse order, that is, from right to left, commencing on the right of the harnesses and drawing from back to front; however, this will not affect the result in the least.

Fig. 13 shows two repeats of a straight drawing-in draft on 5 harnesses and also illustrates another method of representing the harness draft, the lines running across the page representing the harnesses, the vertical lines indicating the warp ends, and the crosses showing through which harness each warp end is drawn. In Fig. 13, the first end is drawn

through the first harness, the second end through the second harness, and so on up to the fifth end, which is drawn through the fifth harness, whereupon the draft commences to repeat, that is, the next end, which is the sixth, is drawn through the first harness, the seventh end is drawn through the second harness, and continues in this manner up to the tenth end, which is drawn through the fifth harness. Here the harness draft commences to repeat again and the next end, which is the eleventh, if it were shown, would be drawn through the first harness.

15. Point Drafts.—Another method of drawing in warps that is used quite extensively is known as the *center*, or *point*, *draft*. In **regular point drafts,** the ends are drawn from the front to the back harness and then the order of drawing in is reversed; that is, after drawing in the end in the back harness the next end, instead of being drawn on the front harness as in the straight draft, is drawn through the next to the back harness and the ends then drawn in regularly from back to front. Fig. 14 is an illustration of a regular point draft on 8 harnesses in which the first end is drawn through the first harness, the second end through the second harness, and so on up to the eighth end, which is drawn through the eighth harness. The next, or ninth end, instead of being drawn through the first harness, as in a straight draft, is drawn through the next to the back, or the seventh, harness and the ends then drawn in from back to front, or in reverse order, the fourteenth end being drawn in through the second harness. The draft commences to repeat here.

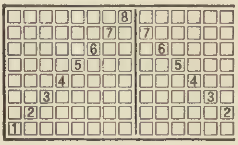


FIG. 14

With a point draft it should be carefully noted that the last end of the repeat should always be drawn through the second harness, that is, if the draft is commenced on the first harness, and that the drawing-in draft should never commence and end with the same harness. It should also be noticed that a regular point draft is always complete on a

number of ends that is two less than twice the number of harnesses employed. Thus, in Fig. 14, the draft occupies 8 harnesses, and one repeat is complete on 14 ends, which is according to the rule, as follows: $2 \times 8 = 16$; $16 - 2 = 14$, the number of ends on which one repeat of the draft is complete.

Another type of point draft, illustrated in Fig. 15, is known as the **irregular point draft.** In these drafts the ends are drawn through the harnesses straight for a certain number of times and then reversed as in a regular point draft; thus in Fig. 15, for example, the ends are drawn in straight on 7 harnesses three times and then reversed. It will be noticed that the last end of the repeat is drawn through the second harness, as previously explained. Still another type of irregular point draft is illustrated in Fig. 16. The method adopted in this case is that of drawing the ends straight for a certain number of harnesses and then reversing, but only running the ends for a few harnesses, when they are again run straight and again reversed, etc. It will be noticed that a repeat of the draft occupies 10 harnesses and 42 ends, and also that the last end of the repeat is drawn through the second harness.

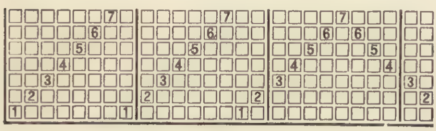


FIG. 15

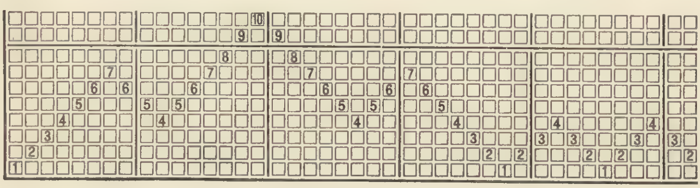


FIG. 16

16. Angled Drafts.—In the method of drawing in the warp ends known as the **angled draft** they are drawn straight for a certain number of harnesses and then reversed, but instead of the reversing starting with the next to the back harness as in the point draft, it is started on an intermediate

harness, generally half way between the first and last harnesses, but depending somewhat on the chain draft that is to be used. Fig. 17 shows an angled draft on 8 harnesses in which the first 8 ends are drawn straight and the method of drawing in then reversed, but instead of commencing with the seventh harness and drawing the ninth end through that harness as in a regular point draft, the ninth end is drawn through the fourth harness, the tenth end through the third harness, and so on until an end has been drawn through each harness, which completes one repeat of the draft.

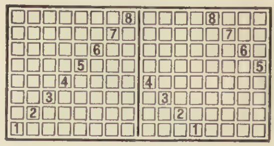


Fig. 17

17. Skip Drafts.—The skip draft may be considered as a straight draft drawn in sections with one or more harnesses skipped between the sections. Fig. 18 shows a skip draft on 4 harnesses in which the first section of 4 ends is drawn in straight; then 1 harness is skipped and the next section of 4 ends drawn straight, then another harness skipped and the next section drawn in straight, and so on. Thus it will be noticed that the fourth end is drawn in on the fourth harness, but the fifth instead of being drawn in on the first harness as in the straight draft, is drawn in on the second harness. In the same way the eighth end is drawn in on the first harness, but the ninth, instead of being drawn in on the second, is drawn in on the third, and so on. It will be noticed that this draft repeats on 16 ends, since if it were continued the seventeenth end would be drawn in on the first harness, as the fourth would be skipped. Thus the seventeenth end would be the first end of the next repeat of the draft. In the draft shown in Fig. 18 only 1 harness is skipped between the sections, but it is perfectly feasible to skip any desired number.

Fig. 18

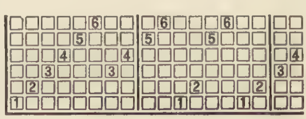


Fig. 19

In Fig. 19 a skip draft on 6 harnesses is shown in which 2 harnesses are skipped between the sections. In this draft the first 6 ends are drawn in straight, but the seventh end skips 2 harnesses and starts on the third, while the thirteenth end, instead of being drawn in straight, skips 2 harnesses and begins on the fifth. In this draft there are really three sections and the draft repeats on 18 ends, since the nineteenth end, if shown, would start on the first harness, the fifth and sixth being skipped.

18. Satin Drafts.—Satin drafts are really adaptations of the skip-draft principle in which harnesses are skipped between the ends instead of between sections of ends. Thus in the 5-harness satin draft shown in Fig. 20, the first end is drawn in on the first harness; the second end is drawn in on the third harness, skipping the second harness; the third end is drawn in on the fifth harness, skipping the fourth harness; the fourth end is drawn in on the second harness, skipping the first harness; and the fifth is drawn in on the fourth harness, skipping the third harness. In this satin draft only 1 harness is skipped between the ends, but in the 8-end satin draft shown in Fig. 21, 2 harnesses are skipped between the ends; thus, the first end is drawn in on the first harness; the second end on the fourth harness, skipping the second and third harnesses; the third end on the seventh harness, skipping the fifth and sixth harnesses; the fourth end on the second harness, skipping the eighth and first harnesses; and so on. It will be noticed that satin drafts repeat in the same manner as the skip drafts; thus in Fig. 20 the sixth end would be drawn in on the first harness, the fifth harness being skipped between the fifth and sixth ends, and in Fig. 21 the ninth end would be drawn in on the first harness, skipping the seventh and eighth harnesses between the eighth and ninth ends.

FIG. 20

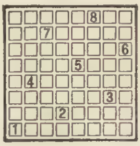


FIG. 21

19. Section Drafts.—A section draft may consist of any one or more of the foregoing styles of drafts arranged so

as to be repeated in sections throughout the width of the cloth. Thus Fig. 22 shows a section draft on 12 harnesses, and as indicated by the brackets the method of drawing in the first section of 4 ends is to be repeated three times, and the method of drawing in the second and third sections of 4 ends is to be repeated the same number of times. Thus, it will be seen that this is really a short method of indicating a comparatively large draft, since if this draft were extended fully as indicated, it would occupy 36 ends, as shown in Fig. 23. This section draft is simply an amalgamation of straight drafts in sections, but it is not necessary to use

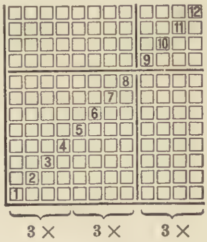


Fig. 22

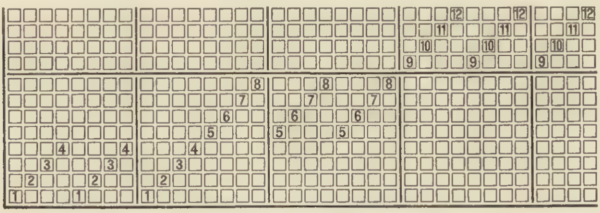


Fig. 23

straight drafts, since angled, skip, or satin drafts may be extended in sections in the same manner.

EFFECTS OF THE HARNESS AND CHAIN DRAFTS

20. That different drawing-in drafts will give widely different results in the cloth, even if the same chain draft is used, is readily apparent. The effect that will be produced in a cloth by any harness and chain draft may be easily ascertained by simply copying the interlacings of each end of the chain draft in the order indicated by the harness draft. The effect is practically the weave, and consequently finding the effect when the harness and chain drafts are given is simply the reverse of finding the harness and chain drafts when the weave is given.

To illustrate this, suppose that Fig. 24 is a chain draft for a weave and that the ends are drawn in straight on 8 harnesses; then the effect in the cloth will be exactly like the chain draft, since the first end will work like the first harness of the chain draft, and consequently the interlacings of that end will correspond to the rising and falling of that harness. Since the second end works like the second harness and so on throughout the draft, the effect will be exactly like the chain draft. When a straight harness draft is used, the chain draft is always exactly like the weave; and on the other hand, the effect, or weave, produced by any chain draft with a straight harness draft is always like the chain draft. Suppose that the same chain draft, Fig. 24, is used, but that the harness draft in Fig. 14 is used in place of the straight draft, and it is desired to find the effect that will be produced in the cloth. As previously stated, the manner in which the harnesses rise and fall, as shown in the chain draft, will give the manner in which the ends drawn through those harnesses interlace with the filling; therefore, if it is desired to learn how a certain end interweaves, it is simply necessary to copy the order of lifting and lowering the harness through which that end is drawn, and since the harness draft shows through which harness any end is drawn, while the chain draft shows when each harness is up and when down, it is possible from these two drafts to tell exactly how each end interweaves. Proceeding in this manner, in order to find the effect produced with Fig. 24 as a chain draft and Fig. 14 as a harness draft, since the first end is drawn through the first harness it will rise and fall with that harness, and consequently the lifting of the first harness as shown in the chain draft represents the manner in which the first end interweaves and is therefore copied for the first end of the effect, as shown in Fig. 25. The second end is drawn through the second harness and the lifting and lowering of

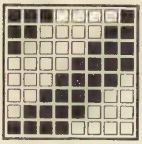


Fig. 24

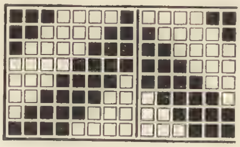


Fig. 25

this harness is therefore copied in order to show the interweaving of this end, and so on up to and including the eighth end; but the ninth end is drawn through the seventh harness, and therefore to show the interweaving of this end it is necessary to copy the order of lifting and lowering that harness as shown in the chain draft. Continuing in this manner until the interlacings of all the ends shown in the harness draft have been copied from the chain draft, the effect shown in Fig. 25 is obtained.

21. For another example suppose that the same chain draft is used with the harness draft shown in Fig. 17 and that it is desired to find the effect that will be produced. Fig. 26 shows the effect, and it is hardly necessary to go into any detailed explanation of the manner in which this is obtained except to call attention to the ninth end. By noticing the harness draft, Fig. 17, it will be seen that the ninth end is drawn through the fourth harness; therefore, in representing this end in the effect it is necessary to copy the lifting and lowering of the fourth harness as shown in the chain draft. By noticing the effect, Fig. 26, it will be seen that the working of the ninth end is similar to the working of the fourth harness as shown in the chain draft, Fig. 24. The working of the tenth end is similar to the working of the third harness, since it is drawn through that harness; the working of the eleventh end is similar to the working of the second harness, since the eleventh end is drawn through that harness; and, in short, by examining the ends as shown in the effect, Fig. 26, it will be seen that they all work in a manner similar to the harnesses through which they are drawn.

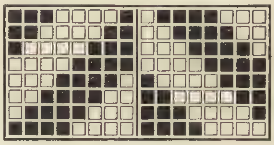


FIG. 26

FIG. 27

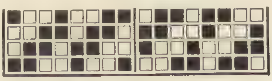


FIG. 28

For another example suppose that it is desired to find the weave produced by the skip draft shown in Fig. 18 with the

chain draft shown in Fig. 27. The first section of 4 ends is drawn in straight; therefore, these ends will be the same as the chain draft; then, according to the drawing-in draft, the fifth end is like the second, the sixth is like the third, the seventh is like the fourth, the eighth is like the first, the ninth is like the third, and so on, as shown by the completed weave in Fig. 28.

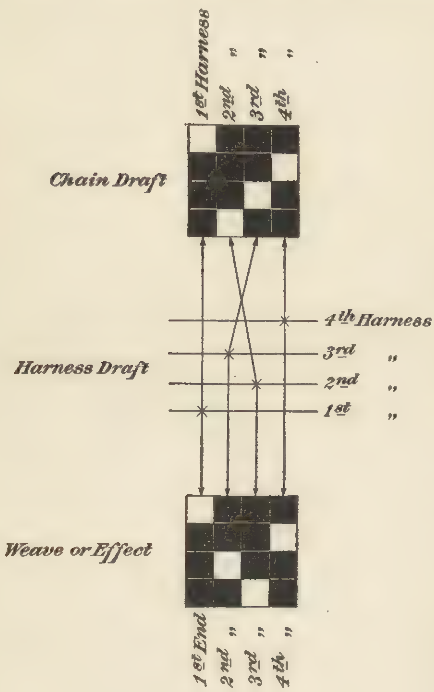


FIG. 29

A final example of the relation between the harness draft, the chain draft, and the effect is shown in Fig. 29. In this figure, the first end, as shown in the harness draft, is drawn through the first harness; therefore, the first end in the weave will be like the first harness in the chain draft. The second end is drawn through the third harness; therefore, the second end in the weave will be like the third harness in the chain draft. The third end is drawn through the second harness; therefore, the third end in the weave will be like the second harness in the chain draft. The fourth end is drawn through the fourth harness; therefore, the fourth end in the weave will be like the fourth harness in the chain draft.

22. From these explanations, it will be seen that by simply altering the harness draft several effects in the cloth can easily be obtained from one chain draft. On the other hand, it will readily be understood that it is possible to

obtain different effects with the same harness draft by simply changing the chain draft, since if the harnesses are made to rise and fall differently it will of necessity cause the ends drawn through these harnesses also to rise and fall differently, thus changing the manner of interweaving the ends and consequently changing the weave. It should, however, be carefully noted that the chain draft and harness draft must always occupy exactly the same number of harnesses.

POINTS TO BE CONSIDERED WHEN CONSTRUCTING HARNESS DRAFTS

23. As has already been shown, when two or more ends in one repeat of a weave have the same interlacings it is possible to draw such ends through the same harness, but it is not always advisable to do so. It would be possible, if the loom would operate the necessary number of harnesses, to draw each end in one repeat of a weave through a separate harness, or in other words to use a straight draft for every weave, in which case one repeat of the weave would always be the chain draft; but owing to the large number of ends occupied by a single repeat of some weaves, it is not always practicable to do so, and consequently it becomes necessary to draw all or some of the ends working alike through the same harness. However, this is a matter in which a person must use his judgment to a large extent, constantly remembering that the nearer the method of drawing in can be brought to a straight draft, the better it will be for the weaving in every way.

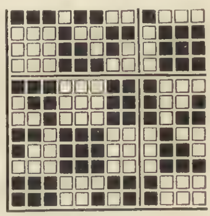
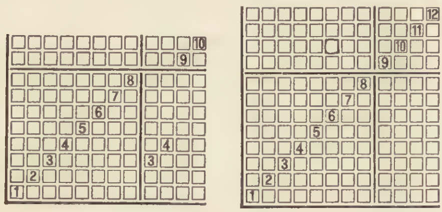


Fig. 30

As an illustration, suppose that the weave shown in Fig. 30 was to be used and that it was desired to make the harness draft. By carefully noting the weave it will be seen that the ninth end works like the third and can therefore be drawn through the same harness as the third end, which is the third harness, and also that the tenth end works like the fourth end

and can therefore be drawn through the harness with the fourth end; thus, the harness draft could be made out as Fig. 31 (*a*), and woven with 10 harnesses, but it will be noticed that by so doing a break is made in the drawing-in draft, which makes it more difficult to draw in the warp and also more difficult for the weaver to draw in any ends that might break out during weaving. A better plan, therefore, is to draw the ends in straight on 12 harnesses, as shown in Fig. 31 (*b*).



(*a*) (*b*)

FIG. 31

24. In order that a better understanding of this subject may be obtained, suppose that it is desired to draft the weave shown in Fig. 32 in the most practical manner. Examining this weave, it will be seen that the first 3 ends are entirely different; therefore, the first end will be drawn through the first harness, the second end through the second harness, and the third end through the third harness. Next it will be seen that the fourth end is like the second and therefore can be drawn through the harness with the second end; also that the fifth, sixth, seventh, and eighth ends interlace in a manner similar to the first, second, third, and fourth, respectively, and therefore can be drawn in the harnesses in the same manner as the first four; and so on up to and including the twenty-fourth end. It will be noticed that the twenty-fifth end works like the ends drawn through the first harness, while the twenty-sixth works like those drawn through the third harness; therefore, these ends are drawn

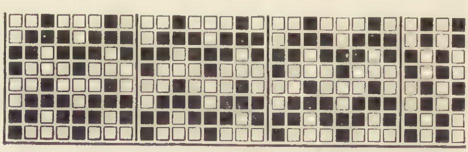


FIG. 32

through the first and third harnesses, respectively. The twenty-seventh end is similar to the twenty-fifth, and the twenty-eighth is like the twenty-sixth. If the ends are drawn in this manner, the harness draft will be like Fig. 33 and the chain draft like Fig. 34.

As previously stated, however, a harness draft should be made out in such a manner that the design can be woven as easily as possible. It will readily be understood that by placing all the ends on 3 harnesses they are more crowded on one or more of the harnesses than if they were placed on more harnesses. Again, increasing the number of ends in the harnesses always adds to the difficulty the weaver has in drawing in the broken ends, and especially so if the warp contains a large number of ends per inch. Another consideration when drafting is to have as nearly as possible the same number of ends on each harness, for then there will be a uniform strain on the harness motion of the loom; while on the other hand, if some harnesses contain more ends than others, heavy and light lifts are forced on the loom mechanism at different times, and a jerky movement of the loom is generally the result.

FIG. 33

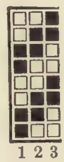


FIG. 34

By noticing Fig. 33, it will be seen that in one repeat of the drawing-in draft 8 ends are drawn through the first and third harnesses, while 12 ends are drawn through the second harness. As a result of this method it would necessarily take more power to lift the second harness than the first or third. In order to remedy this, suppose that instead of drawing the ends as shown in Fig. 33, the first end is drawn through the first harness, the second end through the second harness, the third end through the third harness, the fourth end through the fourth harness, and that this order is repeated until the twenty-fifth end is

FIG. 35

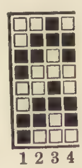


FIG. 36

reached, which is drawn through the first harness, while the twenty-sixth end is drawn through the third harness, the twenty-seventh through the first, and the twenty-eighth through the third. The harness draft for the ends when drawn in this manner is shown in Fig. 35, while Fig. 36 shows the chain draft for this harness draft. It will readily be understood that such an order of drawing in the ends is preferable to that shown in Fig. 33, since the draft is easier for the weaver and drawing-in girl, as well as for the loom.

EXAMPLES FOR PRACTICE

1. Fill 8 × 8 small squares of design paper with the plain weave and show the harness and chain drafts that would be used if the cloth were to be woven on 4 harnesses with a straight drawing-in draft.

2. A plain cloth is to be woven on 4 harnesses with the first end drawn through the first harness, the second end through the third harness, the third end through the second harness, and the fourth end through the fourth harness; show the chain draft.

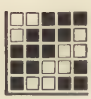


Fig. 37

3. Show the effect that would be produced in the cloth by using a regular point draft with Fig. 37 for the chain draft.

4. (*a*) Show an irregular point draft on 12 harnesses; (*b*) show the effect that would be produced, using Fig. 7 (*a*) for a chain draft.

ANALYSIS OF COTTON FABRICS

PARTICULARS TO BE DETERMINED BY ANALYSIS

INTRODUCTION

1. An important part of every designer's duties is the analysis of fabrics that are sent to the mill from commission houses, from abroad, or from other sources with a view to their reproduction, either as exact duplicates or with certain modifications that the requirements of the buyer or the mill may demand. This analysis, while seemingly of a secondary nature, is of the utmost importance, not only in cases where a mill desires to manufacture certain fabrics for which there is, or is likely to be, a large demand, but also for the purpose of gaining ideas for the production of other fabrics. By the term **cloth analysis** is meant the process of finding all the requirements necessary to reproduce a certain fabric from a given sample. It may not be desired to exactly duplicate the sample, as certain changes in the weight of the goods, the quality of the material used, etc., are often deemed advisable in order to produce a fabric, seemingly the same, that can be placed on the market at less cost. Thus, a sample of cloth may be given to the designer with instructions either to reproduce the goods exactly, or with certain alterations tending to reduce the cost of the goods without materially affecting the appearance. In the case of a small mill that

does not regularly employ a designer, this duty is generally performed by the superintendent or boss weaver.

A sample of cloth may be analyzed by several methods, but it is only by the systematic application of some one method derived from a thorough knowledge of the subject that the most economical and advantageous results are obtained. This subject cannot receive too much study, since it is one with which a designer must of necessity be in daily contact. A designer or student of designing should therefore avail himself of every opportunity to analyze such samples of cloth as he may encounter. By this means he will become acquainted with many weaves and characteristic effects and learn to associate them with certain fabrics, thus understanding them much better than it would be possible to understand the bare designs marked out on design paper.

2. In analyzing a sample of cloth, the following list of particulars should be found, the desired finished width of the cloth being given, of course, in all cases:

1. Sley of cloth (average sley if necessary)
2. Ends in the warp
3. Warp pattern (if any)
4. Number of patterns in the warp
5. Picks per inch
6. Filling pattern (if any)
7. Reed to be used
8. Width at reed
9. Yards per pound
10. Counts of warp
11. Counts of filling
12. Weave
13. Harness draft
14. Chain draft

There are also other particulars that should be considered when reproducing a fabric; these, however, will be dealt with later. Several of the items in this list of particulars belong to the subject of cotton-cloth calculations and consequently need no explanation here. In demonstrating the methods of obtaining the other requirements to be found, the same cloth sample will be used that was adopted to exemplify methods of making cotton-cloth calculations.

WARP PATTERN

3. The **warp pattern** is a requirement that is necessary only when the cloth contains warp yarns of different colors, counts, or materials. To illustrate the method of making out a warp pattern it will be assumed that it is arranged as follows: 1 end 30s light blue, 1 end 2/20s white, 10 ends 30s dark blue, 1 end 2/20s white, 10 ends 30s dark blue, 1 end 2/20s white, 1 end 30s light blue, 4 ends 30s white, 1 end fancy, 4 ends 30s white, 1 end fancy, 4 ends 30s white, 1 end fancy, 4 ends 30s white, 1 end fancy, 4 ends 30s white.

The above shows the warp pattern, but this can be shortened somewhat and made to appear to better advantage by arranging the list in the form of a column, enclosing with a brace each portion that is to be repeated and indicating the number of times the part thus enclosed is to be repeated, as follows:

$$
\begin{array}{rl}
 & 1 \text{ end 30s light blue} \\
 & 1 \text{ end 2/20s white} \\
2 \times & \left\{\begin{array}{l} 10 \text{ ends 30s dark blue} \\ 1 \text{ end 2/20s white} \end{array}\right. \\
 & 1 \text{ end 30s light blue} \\
4 \times & \left\{\begin{array}{l} 4 \text{ ends 30s white} \\ 1 \text{ end fancy} \end{array}\right. \\
 & \underline{4} \text{ ends 30s white} \\
 & 49 \text{ ends in pattern}
\end{array}
$$

Another convenient method of showing this pattern and one that is to be recommended is as follows:

WARP PATTERN

30s light blue .	1						1										2
30s dark blue .			10		10												20
30s white . . .								4		4		4		4		4	20
30s fancy . . .									1		1		1		1		4
2-ply 20s white		1		1		1											3
Total number of ends in pattern																	49

Or this could be somewhat shortened, as follows:

WARP PATTERN

30s light blue	1				1				2
30s dark blue			10						20
30s white						4		4	20
30s fancy							1		4
2-ply 20s white		1		1					3
			2 ×			4 ×			
Total number of ends in pattern									49

The marks 2 × and 4 × show that the ends enclosed with a brace are to be taken two times and four times, respectively. By carefully comparing these last two forms, the method adopted in the second one will be readily understood.

In the case of a piece of cloth like the sample that is to be used for analysis, the warp pattern would be known as all white, while the stripe effect produced in the cloth would be obtained by the method of drawing the ends in the reed and the order of raising the harnesses.

FILLING PATTERN

4. By the term **filling pattern** is meant the manner in which the filling is inserted in the cloth either as regards different colors, materials, or different counts of yarn. In making out the pattern of the filling in any cloth, it is simply necessary to give the number of picks of each color or count in one repeat of the pattern; this can be shown in the same manner as was the pattern of the warp. In case the filling is all one color, material, and counts, there will, of course, be no pattern and it will simply be stated as all white, all black, etc., according to whatever color of yarn is used. With the sample of cloth used for analysis, the filling is white and is all of the same counts; consequently, the pattern of the filling would be stated as all white.

PICKING OUT

5. The *weave* is one of the most important particulars concerning a sample of cloth, as without the correct weave it is impossible to reproduce the fabric with a satisfactory resemblance to the original appearance, especially if the fabric has a pronounced weave effect or a color effect depending on the weave for the disposition of the color on the face of the cloth. The method of obtaining the weave from a sample of cloth will require considerable study and practice, although after the weaves of a few samples have been studied and successfully obtained it will be a comparatively easy matter to obtain the weaves of other samples; in fact, many samples will be met with that will not require much more than a glance to determine the weave. The process of obtaining the weave of a woven fabric is known as **dissecting,** or **picking out,** although these terms are sometimes applied to the entire process of cloth analysis. The weave obtained from picking out a sample of cloth is often spoken of as a **pick-out.** By the term **weave** is meant the manner in which the warp yarns and the filling interlace, and is shown on design paper by means of filled-in squares and blanks; that is, by looking at the weave as shown on design paper it is possible to determine just how each thread of the warp is lifted and lowered.

6. When obtaining the weave of a sample of cloth, the first thing necessary is to determine the face and back of the fabric and also which threads form the warp and which the filling. These two points will be dealt with more fully later, but the importance of determining them before commencing to obtain the weave should be mentioned here. If the back of a cloth were taken as the face, the warp ends would be up when in reality they should be down; the reverse would also be true. On the other hand, if the filling were considered as the warp, a correct reproduction of the sample would not be obtained, because the resulting weave would be turned one-quarter way around on the design paper instead of occupying its actual position as in the cloth. In a twilled

cloth this would have the effect of making the twill run in the wrong direction. If the filling were considered as the warp, the weave would also be reversed, since the filling threads would be marked up on the design paper when in reality, since they are filling threads, they should be left blank where they float on the surface of the cloth. After the face and back, also the warp and filling, have been deter-

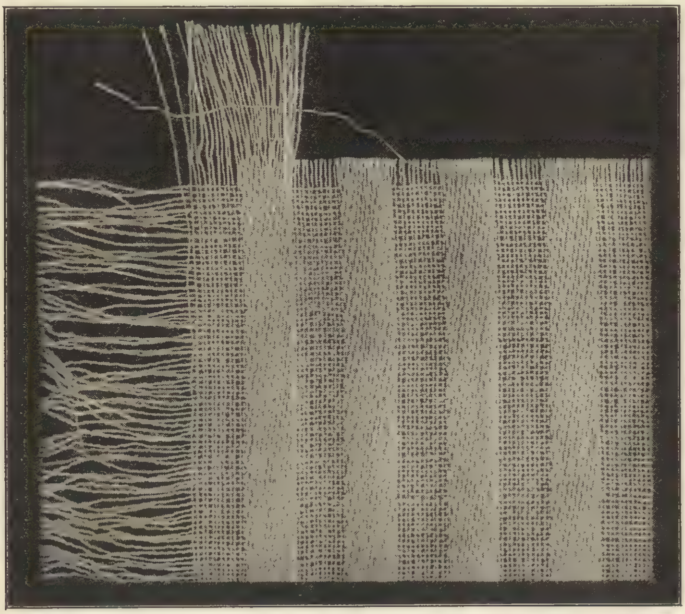


Fig. 1

mined, the sample should be held in such a manner that the face side will be up and the filling will run from side to side.

7. The operation of finding the weave of a sample of cloth consists of picking out one pick of filling at a time and setting down on the design paper the way in which it interlaces with the warp. Thus, if the filling passes over the first end, the square on the design paper representing where that end intersects with the pick under consideration will be left blank, showing that the warp is depressed and that the

filling is on the face of the cloth at that point. If the filling passes under the next end, the square on the design paper representing where the second end intersects with the pick of filling will be filled in, showing that the warp end is raised over the filling at that point.

8. Preparation of Sample.—Before commencing to pick out a weave, the sample of cloth needs certain preparation in order to facilitate the operation. Several ends from the left of the sample and several picks from the top should

Fig. 2

be pulled out. After the picks have been pulled out, all the loose ends should be cut off, with the exception of those needed to determine the weave. It is not desirable to leave too many ends at the top, only sufficient to form one repeat of the weave being needed. As this number cannot always be determined accurately until the picking out is completed, a number slightly in excess of those probably required should remain. When prepared, the sample will appear as in Fig. 1, which is a slightly enlarged photographic reproduction of the sample under consideration when ready to be picked out.

9. After preparation, the sample should be held in the left hand and laid over the first finger, as shown in Fig. 2, so that when an end has been dealt with, it can be drawn under the thumb and held out of the way while determining the intersection of the next end; in this manner it is possible to keep the ends separate and determine their interlacings more readily. For manipulating the ends and picks when determining the interlacings of the weave and when removing the picks from the cloth, an instrument known as a *picking-out*, or *dissecting*, *needle* is used. This consists simply of a stout needle, usually inserted in a wooden handle so that it may be conveniently grasped.

A method that may be used to advantage in many cases is to lay the sample on a white surface if it contains dark-colored yarns, and on a black surface if the yarns are light-colored. By this means the interlacings will often show up much more prominently, especially when working by artificial light. When this second method is used, a *pick glass* will often be of great aid in determining the interlacings of the warp and filling, especially if the sample is woven of fine yarns or if it contains a large number of ends and picks per inch. A **pick glass,** or **linen tester,** as it is sometimes called, is a simple lens, or magnifying glass, contained in a suitable support; it is also used to enable the number of ends or picks per inch to be readily counted. A pick glass with a field of less than 1 inch is undesirable for purposes of analysis.

In either method, the next step is to draw the top pick up a little from the cloth until its interlacings with the ends that have been left can be readily seen. Beginning with the end on the left and taking each end in successive order, indicate on the design paper whether the pick of filling is above or below each end; that is, if the pick is above an end, the square on the design paper is left blank; if the pick of filling is below an end, the square is marked. Proceed in like manner with each end until a repeat is found. It is well to carry the first few picks out two repeats in order to make sure that a repeat of the weave has been found, after which the extra ends may be cut off, as shown in Fig. 1.

The interlacings of the first, or top, pick should be placed on the top row of squares on that portion of the design paper that is intended to be used and the interlacing of the first end, or the end at the left, with the first pick should be shown on the first row of squares at the left on the design paper; that is, the interlacing of the first, or left, end with the first, or top, pick will be shown by the square in the upper left-hand corner of the design paper. The top pick, however, will not be the first pick to be placed in the loom, since this would produce the cloth with the top for the bottom and vice versa. The last pick of the pick-out will therefore be the first pick to be placed in the loom, and consequently the lower left-hand corner of the weave when shown on design paper is considered to represent the interlacings of the first end and first pick. This is difficult for a beginner to understand, but it is simply necessary in this connection to know that when a piece of cloth is picked out after the manner described, the lower left-hand square of the design paper represents the first end and the first pick; this is important when building a harness chain from the draft.

After its interlacings have been found and placed on the design paper, the first, or top, pick should be drawn out of the cloth entirely, and the next pick then drawn up among the loose ends, as when dealing with the first pick. The interlacings of this pick are found and marked on the design paper on the next horizontal row of squares below the row marked for the first pick. After marking the interlacings of the second pick, the third and each successive pick is dealt with in a similar manner until one is found that interlaces in a manner similar to the first pick taken out. This generally indicates that the weave repeats at this point, but it is always a good plan to pick out 3 or 4 picks of filling after it is thought that the weave has commenced to repeat, and compare these with the first picks taken out, to make sure that the weave does repeat at this point. These extra picks must of course be ignored afterwards and only one repeat of the weave used when obtaining further particulars. When one repeat of the weave is obtained, it represents what is repeated as many

times as required in the length and width of the same piece of cloth, and therefore, is all that is necessary.

Some designers prefer to commence at the bottom of a piece of cloth to pick out. In this case, after the interlacings of the first pick have been marked on design paper it is removed from the cloth and the next pick above it examined and marked on the design paper, but in this case it is set down immediately above the one that was first marked. The interlacings of the third pick taken from the cloth are placed above the second, and so on, so that whether the pick-out is commenced at the top or the bottom of the sample, the final result as shown on design paper will be the same.

Some designers also pick out the warp ends instead of picks of filling, marking squares for picks depressed and leaving squares blank for picks raised.

10. The quickest plan of indicating the weave on the design paper when picking out is to prick, with the picking-out needle, the squares that represent warp ends lifted, and then, after the weave has been found, fill in these squares with ink or pencil. This makes it unnecessary to lay down the picking-out needle and take up the pen or pencil every time a square needs to be marked.

If the sample of cloth to be dissected contains a large number of ends and picks per inch, or warp and filling yarns of the same shade, the yarns are liable to become crossed and the wrong end marked on the design paper. To prevent this, it is an advantage first to place the warp threads in a comb, attaching the ends together with mucilage between two pieces of paper in order to prevent their slipping back. If the ends are crossed or in a wrong order when placed in the comb, this fact will be noticed before the weave repeats, and by making a note of where these crossed ends should be, they may be recopied in their proper order after the repeat of the weave is found. This method will be found useful with any cloth difficult to dissect.

A good aid in dissecting warp-backed and double cloths is to cut the backing ends, after the necessary number of picks

have been taken out, about $\frac{1}{8}$ or $\frac{1}{4}$ inch shorter than the face ends. If the fabric is hard felted or has a nap, singe it and scrape off the fiber, being careful not to injure the body of the yarns. In many cases, where the weave of a cloth is regular and one commonly used, such as a regular twill, it will not be necessary after a little experience to pick out more than 1 or 2 picks, since these will show the manner of the interlacings in the whole weave, which can readily be completed without dissecting.

11. Fig. 3 shows one repeat of the weave of the cloth sample. Several different results might be obtained in picking out this one sample of cloth, and yet each be correct. This would be due to the fact that the different pick-outs were not started on the same end or the same pick, in which case the first end of one pick-out would not be the first end

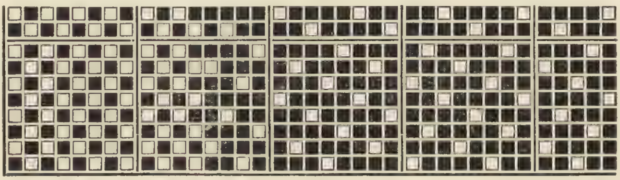


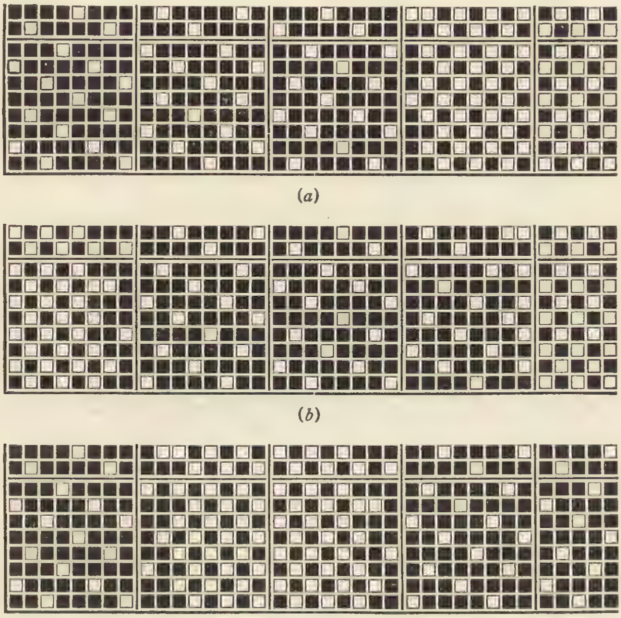
FIG. 3

of the other, or the first pick of one would not be the first pick of the other; or perhaps the pick-out might have been started on both a different end and a different pick.

For instance, if the cloth sample under consideration had been so prepared that the thirteenth end of Fig. 3 was the first end at the left of the sample, with the top pick as there shown still the top pick, the weave in Fig. 4 (*a*) would have resulted. If the sample had been so prepared that the seventh end of Fig. 3 was the first end at the left, the weave obtained would be that shown in Fig. 4 (*b*). Again, if the sample had been so prepared that the twenty-eighth end of Fig. 3 was the first end at the left, the pick-out shown in Fig. 4 (*c*) would have resulted. Though each weave appears to be different from the others, and from Fig. 3, in reality they are all exactly alike, since if repeated several

times in the cloth the same effect will be produced, yet the difference in their appearance is due only to the end on which the pick-out is started.

In a similar manner, if the pick-out had been started on a different pick, it would have had a different appearance, or if it had been started on a different end and different pick from those shown in Fig. 3, the resulting weave would have



(a)

(b)

(c)

FIG. 4

appeared still different. It is usually customary to arrange a combination weave of this character after the manner shown in Fig. 3 or in Fig. 4 (*a*). Designs are sometimes, however, arranged as shown in Fig. 4 (*b*) and (*c*).

By referring to Fig. 3, it will be seen that the first 12 ends of the cloth sample consist of the plain weave, which is complete on 2 ends and 2 picks. Consequently, when picking out a weave of this kind it is only necessary to take out

2 picks in order to learn the weave, after which it may be continued for as many ends and picks as may be desired by simply repeating the first 2 ends and picks. With weaves as simple as this it will be possible, after a little practice, to place the weave on the design paper by simply observing the cloth by means of the pick glass. After the first 12 ends, as shown in Fig. 3, a different weave is employed, and one repeat of this weave is complete on 5 ends, although the entire weave occupies 25 ends. This weave is known as a 5-end warp satin.

One of these weaves, namely the plain weave, is complete on 2 ends and 2 picks, while the satin weave is complete on 5 ends and 5 picks. It might naturally be supposed that in order to show the complete weave only 5 picks would have to be taken out, but the two weaves must repeat together, and a plain weave cannot repeat on an odd number of picks. Consequently, while the satin weave would repeat on 5 picks, the plain weave would not. When two separate weaves are combined in a cloth similar to this one, the weave for the sample will not repeat in its picks until it is continued for a number of picks that is a multiple of the numbers representing the picks on which each weave is complete. Naturally, the least common multiple will give the number of picks on which the entire weave repeats. For example, the plain weave is complete on 2 picks and the satin weave on 5 picks. The least common multiple of 2 and 5 is 10. Therefore, the entire weave is complete on 10 picks.

Another important point that can be illustrated from this sample is the matching up of two weaves when used in the same cloth. By again referring to Fig. 3 it will be noticed that the plain weave is finished on the twelfth end and the satin weave commences on the thirteenth end. In order to have the cloth show as neat an effect as possible, these two ends should *cut*, or oppose, each other; that is, where a square is marked on the twelfth end, the next square to it on the thirteenth end should be left blank. By referring to Fig. 3 it will be seen that on the first pick the twelfth end is down, while the thirteenth end is up; thus they oppose each other.

On the second pick the twelfth end is up and the thirteenth end down, thus causing the 2 ends to oppose each other. They also cut on the third pick, but on the fourth pick both ends are up and consequently do not cut. The effect at this point will not be as neat in the cloth as it is where the ends oppose. However, it is not possible to have a plain weave cut at every point when combined with a 5-end satin.

When desiring to have two weaves cut, both places where the weaves join should be carefully noticed; thus, in Fig. 3 it will be seen that the two weaves not only join at the twelfth and thirteenth ends but also at the first and last, since in showing a second repeat of the entire weave, the first end would be brought next to the last end.

All cloths are not made up of two or more weaves, as this is the exception rather than the rule, and generally a cloth will be found to be made from but one weave repeated a number of times.

HARNESS, OR DRAWING-IN, DRAFTS

12. It is comparatively easy to make the **harness draft** from the weave, but regard should always be had to the best manner of weaving the cloth. Thus, by referring to Fig. 3, which is the weave of the cloth sample shown in Fig. 1, it will be seen that there are more than twice as many ends of the satin stripe as there are of the plain, and by examining Fig. 1 it will be noticed that these ends are cramped or crowded together. In such cases as this it is generally better to place these ends on the front harnesses. As the ends of the satin weave will take at least 5 harnesses, since there are 5 ends working differently, the ends forming the satin stripe, or the last 25 ends in Fig. 3, will therefore be placed on the 5 front harnesses. The reason for placing these ends on the front harnesses is that, as there are more of them, more of them are liable to break during weaving, and it is much easier for a weaver to draw a broken end through a front harness than through a back one. There is also not so much strain on the ends drawn through the front harnesses as there is on those drawn through the back;

consequently, this lessens to a certain degree the liability of these ends breaking.

The ends forming the plain weave will be drawn through the harnesses next to the five on which the ends forming the satin are drawn. The first 12 ends of Fig. 3 could be drawn through 2 harnesses, since they weave plain and every other end works alike, but it will no doubt be found better to draw the ends through 4 harnesses instead of 2 harnesses, since by this means there will be fewer ends drawn through a harness, which will be found to be an advantage in many ways. This draft then will call for 9 harnesses—five for the satin ends and four for the plain. If the loom in which this cloth is to be woven cannot take this number of harnesses but can take seven, the weave must be drafted to 7 harnesses, which is the smallest number on which it is possible for it to be woven.

In many cases there will be found circumstances that will influence the number of harnesses on which to draft a weave. Some of these have been pointed out but many others will be met with in practice; consequently, a student of designing should be constantly looking for new information, especially in a weave room where there is an opportunity for examining a sample of cloth and finding the lowest number of harnesses on which it can be woven and also the actual number of harnesses on which it is being made. If more harnesses are being used than the lowest possible number, the reason should be learned; or on the other hand, if the weave is drafted to the lowest number of harnesses, the reason that extra harnesses are not necessary should be ascertained. It should be stated here that with many weaves it will not be possible to learn the exact number of harnesses that it will take by simply glancing at the pick-out, but it will be necessary to study the interlacings of each end separately and learn if it is similar to any other end in the weave.

13. Beginning with the first end of the pick-out as shown in Fig. 3, this end will be drawn through the sixth harness, the second end through the seventh harness, the third end through the eighth harness, the fourth end through the

ninth harness, and then the ends will commence to repeat; that is, the next end will be drawn through the sixth harness; and so on for the first 12 ends. Commencing next with the thirteenth end, or the first end of the satin weave, this end will be drawn through the first harness, the fourteenth end through the second harness, the fifteenth end through the third harness, the sixteenth end through the fourth harness, and the seventeenth end through the fifth harness. At this point the ends will begin to repeat; that is, the eighteenth end will be drawn through the first harness, and so on. Fig. 5 shows the harness draft complete. In *Cotton Cloth Calculations* it was shown that this cloth contains eighty-eight patterns and 8 ends over, and since the draft shown in Fig. 5 shows how the ends in only one repeat are drawn in, it must be repeated eighty-eight times in order to draw in all the

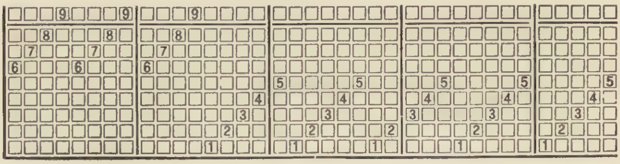


FIG. 5

ends in the warp. The 8 extra ends are to be used for the plain; therefore, the person drawing in the warp will finish by drawing in 8 ends of plain after finishing drawing in the eighty-eight repeats.

By referring to Fig. 5, it will be seen that if, after one repeat has been drawn in, the first end of the second repeat is drawn through the sixth harness, this will bring the same number of ends on each of the last four harnesses. But for the purpose of illustration suppose that there are only 10 ends of plain; then the last end of plain, as shown in the drawing-in draft, will be drawn through the seventh harness, and if the first end of the second repeat is drawn through the sixth harness, this will bring more ends on the sixth and seventh harnesses than on the eighth and ninth. Consequently, the person drawing in the warp can begin the first end of plain in the second repeat on the eighth harness instead of the sixth.

This will give the same effect in the cloth, since the sixth and eighth and the seventh and ninth harnesses work alike; it will also give the same number of ends on each harness.

14. It is always advisable when making out a harness draft first to make it out in such a manner that it will be as nearly a straight draw as possible; this is a great aid to the weaver when drawing in broken ends. Second, as nearly as possible the same number of ends should be placed on each harness; this is a great aid to the good running of the loom. Third, if it is necessary to have more ends on certain harnesses than on others, those harnesses with the most ends should be placed at the front of the loom, unless there is a good reason for not doing so.

CHAIN DRAFT

15. Since the **chain draft** is obtained from the pick-out and the harness draft, it is necessary to have these two items before this draft can be obtained. By referring to Fig. 5, which shows the harness draft, it will be seen that the first end is drawn through the sixth harness; therefore, the interlacings of the first end, as shown in the pick-out, must be the workings of the sixth harness; or in other words, the interlacings of the first end, as shown in the pick-out, give the manner of raising and lowering the sixth harness. The second end is drawn through the seventh harness; therefore, the interlacings of the second end, as shown in the pick-out, give the manner of raising and lowering the seventh harness. The third end is drawn through the eighth harness, and consequently the eighth harness will be raised and lowered as indicated by the third end of the pick-out. The fourth end is drawn through the ninth harness, and the operation of this harness, as shown in the chain draft, will be the same as the fourth end shown in the pick-out. The fifth end is drawn through the sixth harness, but since the working of this harness has already been obtained nothing more needs to be done with this. The same is true of all the ends until the thirteenth

is reached, which is drawn through the first harness; consequently, the interlacing of the thirteenth end, as shown in the pick-out, will give the workings of the first harness. For the same reason, the second harness will work like the fourteenth end of the pick-out; the third harness will work like the fifteenth end of the pick-out; the fourth harness, like the sixteenth end; and the fifth harness, like the seventeenth end. This will complete the chain draft, since the manner of raising and lowering all the harnesses has been learned. Fig. 6 shows the completed chain draft made from the harness draft, Fig. 5, and the pick-out, Fig. 3.

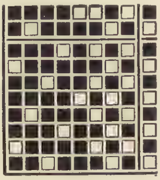


FIG. 6

ADDITIONAL POINTS TO BE DETERMINED BY ANALYSIS

16. In addition to the requirements listed in Art. **2**, there are several items that must in most cases be determined when analyzing a fabric. Some of these items are unnecessary in themselves, but must be ascertained in order that still others may be accurately found. These items are as follows: (1) determination of face and back of fabric; (2) determination of warp and filling; (3) determination of the direction of twist in warp and filling; (4) finding the percentage of contraction in the length of the warp during weaving; (5) the number of beams necessary for the warp yarn; (6) the raw material.

DETERMINATION OF FACE OF FABRIC

17. As previously explained, when desiring to find the pick-out of a sample of cloth it is always necessary first to determine which is the face and which is the back, in order that the results obtained may be accurate for reproducing the cloth.

In most fabrics this is easily done, although some cloths baffle the most experienced designer. The face of a cotton

fabric will sometimes show a much clearer and better pattern than the back. By noticing the cloth sample that has been dealt with, it will be seen that the satin stripe on one side of the cloth shows up much more prominently than it does on the other side. The side that shows the design more prominently is the face. When the fabric is a backed or double cloth, the face can be readily distinguished from the back by means of the style of the cloth or the finish. When dealing with warp-backed fabrics, the face can be readily distinguished from the back, since in this case there will be ends floating for some distance at the back. In a filling-backed fabric, the backing filling floats on the back of the cloth and is generally a soft-twisted yarn in order to give bulk to the cloth.

DETERMINATION OF WARP

18. There are several methods by which the warp may be distinguished from the filling. If the sample submitted for analysis contains a part of the selvage, the warp can be readily distinguished from the filling, since the selvage ends always run in the direction of the warp. In many cases the body of the cloth will be found to be woven from single yarn, while the selvage is woven from 2-ply, or double, yarn. If the yarns in one system are harder twisted, or have more turns of twist per inch, than those in the other, the harder-twisted yarns are generally the warp yarns. If the sample of cloth has what is called a face finish, or nap, the direction of the nap indicates the warp, since these cloths have passed through the machine in the direction of the warp. The counts, or numbers, of the yarn used in each system will often assist in indicating which is the warp and which is the filling, since in many cases the warp yarns are of coarser counts than the filling. If in any case one series of yarn is of different materials, such as cotton and wool or cotton and silk, while the other series of yarn is of one system, the series of yarn that is composed of different systems is generally the warp yarn, although this is not an invariable rule. If one system of yarns has been sized and the other has

not, the former is the warp. This is difficult to determine after the cloth has been finished, but is a good test for brown —i. e., unbleached—cotton goods. If the sample contains reed marks, they will indicate the warp, since they always run warp-way. These marks are caused by the reed wires getting out of place, thereby crowding some of the ends near them and allowing others too much space. In any fabric of a striped character, or in a checked effect in which one direction of the lines is prominent compared with the other, the direction of the stripes or the prominent lines in the check usually indicate the direction of the warp. The twill, if the design is a twill, generally runs up diagonally from the left to the right, so that if the face of the cloth is ascertained it will be readily seen which is warp and which is filling. If one series of yarns is ply and the other single, the ply yarns are generally the warp. In samples of cloth similar to that considered in this Section, the stripes always run warp-way.

DETERMINATION OF TWIST

19. By the term **twist** of yarn is meant both the direction of the twist and also the amount of twist; that is, the number of turns of twist per inch placed in the yarn. The direction of the twist of the yarns in a cloth becomes an important matter when reproducing cloth, since a different effect will sometimes be produced by simply changing the twist in either the warp or filling. Yarns may be twisted in one of two directions, which are technically known as *right twist* and *left twist*. There is considerable difference of opinion as to what constitutes a right-twist or a left-twist yarn, as some mills consider as right-twist what other mills consider left-twist yarn. However, the character of the yarns to which these names are most commonly applied will be explained here.

By holding the yarn between the thumb and forefinger of each hand, the direction of the twist may be learned. If when turning the yarn from the body with the right hand it is twisted harder, it is left-twist; but if the yarn is untwisted

when turned in this manner, it is right-twist. Another method of determining the twist of the yarn is to observe which way the twist marks on the surface of the thread are inclined when the thread is held upright. If they slant up to the left, the yarn is left-twist; if up to the right, it is right-twist. This is the method adopted with screws for determining the twist of the screw thread. Fig. 7 represents a yarn that would be known as a right-twist yarn, while Fig. 8 illustrates a left-twist yarn. By closely examining the warp yarns in the sample, it will be seen that they are right-twist.

FIG. 7

FIG. 8

As previously stated, twist also refers to the number of turns of twist that are put in the yarn in 1 inch. In case of a ply yarn this can be readily ascertained by putting the yarn under the pick glass; or it can be found with more accuracy by untwisting a given length of yarn and dividing the number of turns of twist by the number of inches measured.

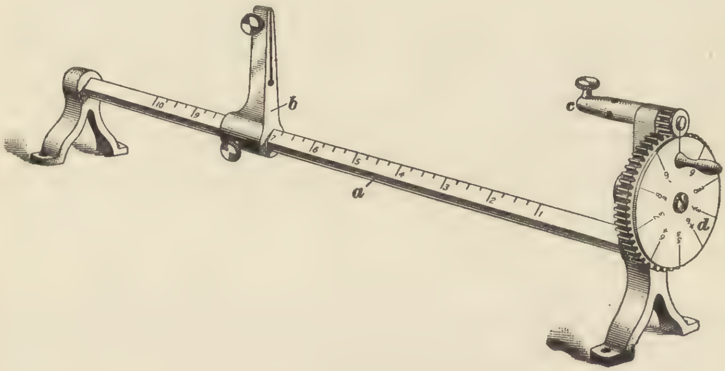


FIG. 9

20. Twist Counter.—The amount of twist in any yarn may be determined by means of an instrument made for the purpose of untwisting the yarn and registering the number of revolutions made in taking out all the twist; this instrument is known as a **twist counter.** The simplest and most commonly used form is shown in Fig. 9. It consists

primarily of two jaws, one of which *b* is capable of adjustment on a bar *a*; the other jaw *c* may be rotated, the exact number of turns that it makes being indicated on a graduated dial *d*. The counter is adapted for finding the number of turns in a sample of yarn from 1 to 10 inches in length, whether right or left twist. The yarn is held firmly by the jaws at a given distance apart as indicated by the position of *b* on *a*; the jaw *c* is then rotated until all the twist is taken out of the yarn, the instrument recording the number of turns on the dial *d*.

TAKE-UP IN WEAVING

21. In making out an order for the amount of warp yarn to be run through the slasher for any loom beam, it will be necessary to learn the probable percentage of contraction that will take place during weaving. For instance, if it is desired to produce 500 yards of cloth from a warp on one loom beam, a somewhat larger number of yards of warp yarn will have to be placed on the beam, owing to the contraction that will take place during weaving. The manner of ascertaining the contraction of any cloth during weaving was dealt with in *Cotton Cloth Calculations*, but it should be borne in mind that no hard-and-fast rules can be laid down for contraction of warp yarns, as this is largely a matter of experience, since some weaves take up much more than others during weaving. The kind of weave, the counts of the warp and filling, and the number of picks per inch are the most important factors that regulate the take-up of the warp, and these should always be carefully considered when desiring to learn the number of yards of warp necessary to weave a certain number of yards of cloth.

NUMBER OF BEAMS REQUIRED

22. In many cases, when desiring to reproduce a sample of cloth, it will be necessary to place the warp yarns on different beams. In some cases as many as four beams are used. For instance, in case a weave that interlaces only once in 6 or 8 picks is combined with plain cloth, the part of

the warp yarn that forms the plain weave will be taken up more rapidly than the other. In such a case it will be necessary to place those ends that form the plain weave on an entirely separate beam, since if this were not done the ends of the plain weave contracting so much more than the other ends would cause the latter to work slack and thus cause a defective cloth. In some cases a cloth may be regular, therefore apparently requiring only one beam, with the exception that at certain intervals there will be a fancy thread that will have different interlacings from the body of the cloth in order that it may produce some desired effect. In this case the fancy threads are placed on a separate beam or, if there are only a few, they are wound on a spool, which may be adjusted at the back of the loom.

When dissecting any cloth, to determine the number of beams required, the weave should be carefully considered. If the cloth is made entirely from one weave, it will be simply necessary to use one beam, but in cases where the cloth is woven with separate weaves, it will be necessary to study these weaves carefully and to ascertain whether one will take up more than the other. The most essential point to notice is the number of interlacings that each weave makes in a certain space. For instance, the ends of one weave may interlace with the filling six times in a certain number of picks, while the ends of another weave may interlace twelve times in the same number of picks. When such is the case, the ends interlacing the greater number of times will, of course, take up much more than the others, on account of their having to bend around the filling much more frequently; consequently, it will be found best in such instances to place the two systems of yarns on separate beams.

Double cloths and cloths backed with warp often require two beams, one for the face warp and one for the back warp, since the back weave is generally different and also because coarser yarns are used for the back of the fabric. If the same yarn and weave are used for the back as for the face of a double cloth, both warps can be put on one beam.

DETERMINATION OF RAW MATERIAL

23. In many fabrics there is a mixture of materials; for instance, cotton and woolen or worsted yarns are often used in the same fabric, as well as cotton and silk. In such cases it will be necessary to determine which yarns are of one material and which are of another. The readiest method of ascertaining the difference between animal and vegetable fibers is to burn some of the yarn. Vegetable fibers are composed of carbon, hydrogen, and oxygen, and when burned will make a flame, emit no odor, and leave an ash. Animal fibers are composed of the same elements together with nitrogen, and when burned will not flame, but smoulder, coil up, and form into a small, crisp globule. They are also distinguished by a peculiar odor that is similar to that of burned horn or feathers. A knowledge of the different fibers is also a great aid in determining the different materials in case threads of different fibers are used in the same fabric. Silk can generally be distinguished from either cotton, wool, or worsted by its incomparable luster and also by the fact that it is generally finer. However, mercerized cotton, which also has a remarkable luster, should not be confounded with silk. These two yarns may be distinguished by burning, as silk is an animal fiber while cotton is a vegetable fiber.

Linen may be distinguished from cotton from the fact that the thread is rougher and contains uneven bunches. It may also be distinguished from cotton by its harsher feeling.

In case it is desired to learn the percentage of the different materials in fancy threads, such as cotton and wool or cotton and silk mixed, or to determine the proportions of each material in a yarn made from two or more different kinds of raw stock, it will be necessary to make chemical tests. When a sample of yarn or cloth is to be tested in this manner it should first be thoroughly washed so as to remove any sizing or foreign matter that may exist. Afterwards dry it thoroughly and weigh it if the percentage of each kind of material is desired.

24. The following tests will cover the separation of silk, cotton, wool, or linen that may be combined in one yarn or cloth. To separate wool from cotton, leaving the cotton: Clean, weigh, and then boil the sample gently for 2 hours in an 8° B. solution of caustic potash; then wash and dry. During the boiling a few drops of water are added from time to time to prevent the alkali from becoming too concentrated. After drying at 100° C. (212° F.), the residue is weighed, which gives the weight of cotton, the loss being the weight of the wool. Instead of potash, a 7° B. solution of caustic soda may be used, and the sample boiled for 15 minutes.

NOTE.—B. means Baumé and refers to the graduated scale on Baumé's hydrometer used for determining the density of a solution.

25. To separate cotton from wool, leaving the wool: Immerse the sample in ammoniacal copper oxide for 20 minutes, after which add water to the solution; then filter and wash, dry and weigh the residue. The weight will be the amount of wool in the mixture.

26. To separate silk, cotton, and wool: Take two samples each of the same weight; boil them from $\frac{1}{4}$ to $\frac{1}{2}$ hour in a 3° B. solution of hydrochloric acid to remove the sizing, etc.; then wash them. Immerse one sample in a boiling solution of basic zinc chloride for a short time; then wash thoroughly, first in acidified and then in clean water, and dry it. The loss in weight gives the amount of silk. Boil the second sample for 15 minutes in a 7° B. solution of caustic soda, and then wash and dry it. The residue is cotton, to the air-dry weight of which must be added about 5 per cent. to compensate for the loss of the fiber during the operation. The difference between this and the original weight represents the weight of wool.

ANALYSIS OF WOOLEN AND WORSTED FABRICS

PARTICULARS TO BE DETERMINED BY ANALYSIS

INTRODUCTION

1. An important part of every designer's duties is the analysis of fabrics that are sent to the mill from commission houses, from abroad, or from other sources with a view to their reproduction, either as exact duplicates or with certain modifications that the requirements of the buyer or the mill may demand. This analysis, while seemingly of a secondary nature, is of the utmost importance, not only in cases where a mill desires to manufacture certain fabrics for which there is, or is likely to be, a large demand, but also for the purpose of gaining ideas for the production of other fabrics. By the term **cloth analysis** is meant the process of finding all the requirements necessary to reproduce a certain fabric from a given sample. It may not always be desired exactly to duplicate the sample, as certain changes in the weight of the goods, the quality of the material used, etc., are often deemed advisable in order to produce a fabric, seemingly the same, that can be placed on the market at less cost. Thus, a sample of cloth may be given to the designer with instructions either to reproduce the goods exactly or else with certain alterations tending to reduce the cost of the goods without materially affecting the appearance. In the case of a small mill that

does not regularly employ a designer, this duty is generally performed by the superintendent or boss weaver.

A sample of cloth may be analyzed by several methods, but it is only by the systematic application of some one method derived from a thorough knowledge of the subject that the most economical and advantageous results are obtained. This subject cannot receive too much study, since it is one with which a designer must of necessity be in daily contact. A designer or student of designing should therefore avail himself of every opportunity to analyze such samples of cloth as he may encounter. By this means he will become acquainted with many weaves and color effects and learn to associate them with certain fabrics, thus understanding them much better than it would be possible to understand the bare designs marked out on design paper.

2. In analyzing a sample of cloth the following list of particulars should be found, the desired finished width of the cloth being given, of course, in all cases:

1. Weight of 1 yard, given width
2. Ends per inch in finished cloth
3. Picks per inch in finished cloth
4. Warp pattern (if any)
5. Ends in pattern
6. Ends in warp
7. Patterns in warp
8. Filling pattern (if any)
9. Counts of warp in finished cloth
10. Counts of filling in finished cloth
11. Weight of warp yarn, each color
12. Weight of filling yarn, each color
13. Reed and ends per dent
14. Width in reed, including selvages
15. Weight from loom, including selvages
16. Weave
17. Harness, or drawing-in, draft
18. Chain draft

Many of these items belong to the subject of cloth calculations and therefore will not require any further explanation. In demonstrating the methods of obtaining the other requirements to be found, reference will be made to the same sample of cloth that was used in dealing with the subject of woolen- and worsted-cloth calculations. In addition to the requirements given in the above list there are several of minor importance that should be considered when reproducing a fabric; these, however, will be dealt with later.

WARP PATTERN

3. The **warp pattern** is a requirement that is necessary only when the cloth contains warp yarns of different colors, counts, or materials. There are several methods according to which a warp pattern may be made out. The best is that which employs a diagram to separate the colors, since there is then less liability of confusion and mistakes. In the sample of cloth under consideration the yarns are arranged in the warp 12 ends of brown and 12 ends of white; its pattern is indicated, according to the method above, as follows:

WARP PATTERN

Brown	12		12
White		12	12

Total number of ends in pattern 24

4. As the above is a very simple pattern, a more complicated one will also be taken for the purpose of illustration. Suppose this pattern to be as follows: 1 end of light blue, 1 end of white, 10 ends of dark blue, 1 end of white, 10 ends of dark blue, 1 end of white, 1 end of light blue, 4 ends of slate, 1 end of fancy, 4 ends of slate, 1 end of fancy, 4 ends of slate, 1 end of fancy, 4 ends of slate, 1 end of fancy, 4 ends of slate. The same method is applied to this pattern as to the previous one, thus:

WARP PATTERN

Light blue . .	1						1										2
Dark blue . .			10		10												20
Slate								4		4		4		4		4	20
Fancy									1		1		1		1		4
White		1		1		1											3

Total number of ends in pattern 49

In a pattern like the one given, where there is a repetition of certain combinations of ends in the pattern itself, the representation of the pattern can be reduced as follows:

WARP PATTERN

Light blue	1				1				2
Dark blue			10						20
Slate						4		4	20
Fancy							1		4
White		1		1					3
			2×			4×			
Total number of ends in pattern									49

The marks 2 × and 4 × indicate that the combinations of ends enclosed with a brace are taken two and four times, respectively. By carefully comparing these two forms the method adopted in the second will be readily understood and it will be seen that both patterns are the same. Another common method of indicating a warp pattern is to arrange the list of colors in the form of a column, enclosing with a brace each portion that is to be repeated and indicating the number of times that the part thus enclosed is to be repeated. With the pattern previously shown this would be as follows:

$$
\begin{array}{ll}
 & \text{1 end light blue} \\
 & \text{1 end white} \\
2\times & \left\{\begin{array}{l}\text{10 ends dark blue} \\ \text{1 end white}\end{array}\right. \\
 & \text{1 end light blue} \\
4\times & \left\{\begin{array}{l}\text{4 ends slate} \\ \text{1 end fancy}\end{array}\right. \\
 & \underline{\text{4 ends slate}} \\
 & \text{49 ends in pattern}
\end{array}
$$

FILLING PATTERN

5. By the term **filling pattern** is meant the manner in which the filling is inserted in the cloth, either as regards different colors, materials, or counts of yarn. In making out the pattern of the filling of any cloth, it is simply necessary to give the number of picks of each color or count in one repeat of the pattern; this can be shown in the same manner as the pattern of the warp. In case the filling is all of one color, material, and counts, there will of course be no pattern and it will simply be stated as all white, all black, etc., according to whatever color of yarn is used. In the sample of cloth under consideration the filling pattern is exactly the same as the warp pattern, which has previously been given.

DISSECTING, OR PICKING OUT

6. The *weave* is one of the most important particulars concerning a sample of cloth, as without the correct weave it is impossible to reproduce the fabric with a satisfactory resemblance to the original, especially if the fabric has a pronounced weave effect or a color effect depending largely on the weave for the disposition of the color on the face of the cloth. The method of obtaining the weave will require considerable study and practice, although after the weaves of a few samples of cloth have been studied and successfully obtained it will be a comparatively easy matter to obtain the weaves of other samples; in fact, many samples will be met with that will not require much more than a glance to determine the weave. The process of obtaining the weave from a woven fabric is commonly known as **dissecting,** or **picking out,** although these terms are sometimes applied to the whole process of cloth analysis. The weave obtained from picking out a sample of cloth is often spoken of as a **pick-out.**

By the term **weave** is meant the manner of interlacing the warp and filling, this being shown on design paper by means of filled-in squares, or *risers*, which represent the warp

floating over the filling, and blank squares, or *sinkers*, which represent the filling floating over the warp.

7. When a sample of cloth is to be picked out, the first thing to be determined is the face and back of the fabric and also which system of threads constitutes the warp and which the filling. These two points will be further discussed later, but the importance of determining these particulars before starting to pick out the weave should be mentioned here. If the back of the cloth were taken for the face, the warp ends would be up when in reality they should be down and down when they should be up. On the other hand, if the filling were considered as the warp, a correct pick-out could not be obtained, since filling threads would be marked up on the design paper when in reality, since they are filling threads, they should be left blank; and at the same time the weave obtained would be turned one-quarter way around. In a twilled cloth this latter would have the effect of making the twill run in the wrong direction. After the face and back, and also the warp and filling, have been determined, the sample should be held in such a manner that the face side will be up and the filling will pass from side to side.

8. As the term *picking-out* implies, the operation of finding the weave from a sample of cloth consists in picking out each pick of filling separately and setting down on design paper the manner in which it interlaces with the warp. Thus, if the filling passes under the first warp end, the square on the design paper representing where that end intersects with the pick under consideration will be filled in, showing that the warp end is raised over the filling at that point. If the pick of filling passes over the second warp end, the square on the design paper representing where the second end intersects with the pick of filling will be left blank, showing that the warp is depressed and the filling is on the face of the cloth at that particular point.

9. Preparation of Sample.—Before commencing to pick out the weave, the sample of cloth needs a certain amount of preparation in order to facilitate the operation.

Several ends from the left side of the sample and several picks from the top should be pulled out, after which all loose ends, except those needed to determine the weave, should be cut off. Generally it is sufficient to leave only enough ends for the repeat of the weave, but before cutting them off be sure that enough ends for a repeat have been left. When

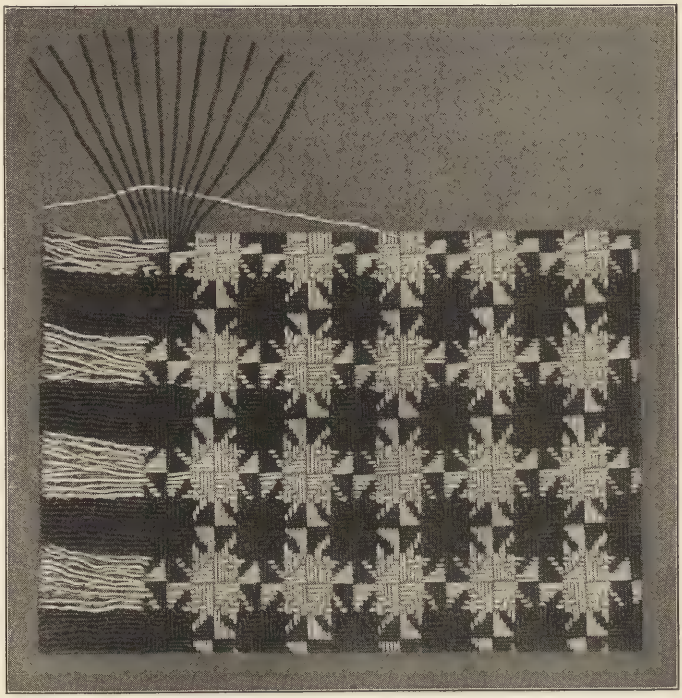


FIG. 1

the preparation of the sample is completed it will have an appearance similar to that shown in Fig. 1, which is a slightly enlarged photographic reproduction of the sample when ready to be picked out.

10. After preparation, the sample should be held in the left hand and laid over the first finger, as shown in Fig. 2, so that when the intersection of each end with the first, or top,

pick has been determined, that end may be drawn under the thumb and held out of the way while determining the intersection of the next end. In this manner it will be possible easily to keep the ends separate and determine the interlacing of each consecutive end with the pick.

For manipulating the ends and picks when determining the interlacings of the weave and when removing the picks from the cloth, an instrument known as a *picking-out*, or

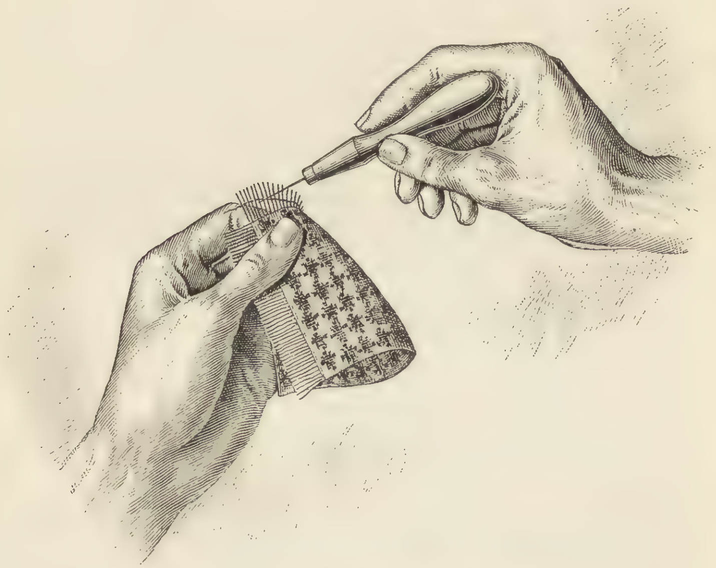


Fig. 2

dissecting, *needle* is used. This consists simply of a stout needle, usually inserted in a wooden handle so that it may be conveniently grasped.

A method that may be used to advantage in many cases is to lay the sample on a white surface if it contains dark-colored yarns, and on a black surface if it contains light-colored yarns. By this means the interlacings and individual threads will stand out much more prominently, especially when working by artificial light. When this method is used,

a *pick glass* will often be of great aid in determining the interlacings of the warp and filling, especially if the sample is woven of fine yarns or if it contains a large number of ends and picks per inch. A **pick glass,** or **linen tester,** as it is sometimes called, is a simple lens, or magnifying glass, contained in a suitable support; it is also used to enable the number of ends or picks per inch to be counted readily. A pick glass with a field of less than 1 square inch is undesirable for purposes of analysis.

In either method, the top pick should be drawn slightly from the body of the cloth until its interlacings with the ends can be plainly seen. Then commencing with the end of the warp at the left and taking each end in succession, indicate on design paper whether the end is above or below the pick of filling. If the first end is above the pick of filling, it will be represented by a filled square on the design paper; if it is below the pick, the square will be left blank. Proceed in like manner with each end until a repeat is found. It is well to carry the first few picks out two repeats in order to be sure of a repeat of the weave, after which the extra ends may be cut off as shown in Fig. 1.

The interlacings of the first, or top, pick should be placed on the top row of squares on the design paper and the interlacings of the first end, or the end at the left, with the first pick should be placed on the first square at the left on the design paper; that is, the interlacing of the first, or left, end with the first, or top, pick will be shown by the square in the upper left-hand corner of the design paper. It should be understood that the top pick is not the first pick that is put in the loom, although it is the first pick picked out. If the top pick of the weave were the first one put in the loom the weave would be reproduced in reverse order; that is, top for bottom. This being the case, it will be seen that the last pick of the weave removed will be the first pick put in the cloth in the loom; consequently, the lower left-hand corner of the weave, when placed on design paper, is then considered to represent the intersection of the first end and first pick. This is difficult for a beginner to comprehend, but must be

thoroughly understood, since it is an important point when building a harness chain from the draft.

After its interlacings have been found and placed on the design paper, the first, or top, pick should be drawn out of the cloth entirely and the next pick raised among the loose ends, so that its intersections may be found in the same manner as those of the first pick. The intersections of the second pick should be placed on the horizontal row of squares directly below the row of squares on which the intersections of the first pick were marked. After marking the interlacings of the second pick, proceed in a similar manner with the third and each successive pick until a pick is found that interlaces with the warp in the same manner as the first pick. This generally indicates that the weave repeats at this point, but it is a good plan to pick out three or four more picks and compare them with the first ones taken out, in order to be sure that the weave does repeat at this point. These extra picks must be ignored afterwards and only one repeat of the weave used when finding further particulars. When one repeat of the weave is obtained, it represents what is repeated as many times as required in the width and length of the cloth, and is therefore all that is necessary.

Some designers prefer to commence at the bottom of a piece of cloth to pick out. In this case after the interlacings of the first pick have been marked on design paper it is removed from the cloth and the next pick above it is examined and marked on the design paper, but in this case it is set down immediately above the one that was first marked. The interlacings of the third pick taken from the cloth are placed above the second, and so on, so that whether the pick-out is commenced at the top or the bottom of the sample, the final result as shown on design paper will be the same.

11. The best plan of indicating the weave when picking out is to prick with the picking-out, or dissecting, needle the squares that are required to be marked and afterwards mark them with ink or pencil. This method makes it unnecessary

to lay down the picking-out needle and take up the pen or pencil every time a square needs to be marked.

If a sample contains a large number of ends and picks per inch, or warp and filling yarns of the same color, the yarns are liable to become crossed and the wrong end marked on the design paper. To prevent this it is an advantage, before starting to pick out, to place the warp threads in a comb, fastening the ends together between two pieces of paper with mucilage, in order to prevent their slipping back. If the ends are crossed or in the wrong order when placed in the comb, this fact will be noticed before the weave repeats, and by making a note of the places where these crossed ends should be, they may be recopied in their proper order after the repeat of the weave is found. This method will be found useful with cloth difficult to dissect.

It often happens that a certain sample, owing to the large number of warp ends that it contains, is much easier to pick out if the ends are removed from the cloth instead of the picks, but in this case the squares must be filled in for those picks (considered as ends) that are down and left blank for those that are up. Unless this is done the reverse of the weave in the sample will be obtained on the design paper.

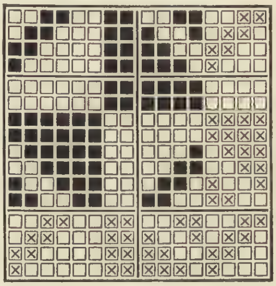
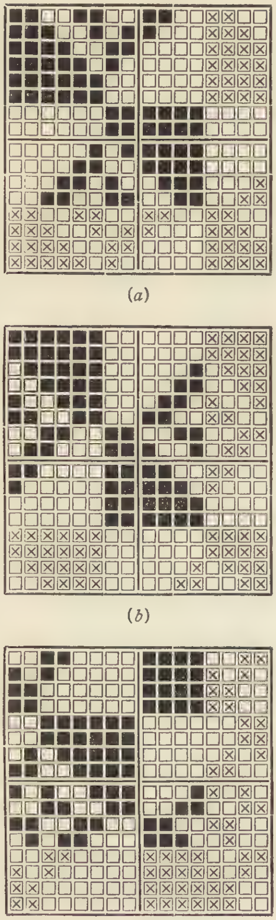


FIG. 3

A good aid when picking out warp-backed and double cloths is to cut the backing ends about $\frac{1}{8}$ or $\frac{1}{4}$ inch shorter than the face ends, after having removed a sufficient number of picks for dissecting purposes. If the fabric is hard-felted or has a nap, singe the sample with a match and with a knife scrape off the fiber, being careful not to injure the body of the yarn. In many cases where weaves are of regular order, as twills or weaves that are very frequently used, it will not be necessary to pick out the weaves, since they will be readily recognized from the appearance of the fabric.

12. In Fig. 3, the pick-out for the cloth sample under consideration is shown. It will be noticed that 4 ends and 4 picks are marked with crosses, while the rest of the weave is filled in solid. These are extra ends and picks that have been picked out, in order to make sure that one repeat of the pattern has been obtained. When greater confidence has been obtained, it will not be necessary to pick out many extra ends and picks in simple weaves. This is desirable, however, in the more complicated weaves. The solid, or filled-in squares, represent one repeat of the weave, which it will be seen is a check weave on 12 ends and 12 picks.



(*a*)

(*b*)

(*c*)

Fig. 4

Several correct but apparently different results might be obtained in picking out a sample of cloth, owing to the fact that the pick-outs might not have been started on the same end or the same pick; in this case each end and pick will be the same in each pick-out, but arranged in different order.

For instance, if the cloth sample had been so prepared that the seventh end of Fig. 3 was the first end at the left of the sample and the top pick of Fig. 3 was still the top pick of the sample, the weave shown in Fig. 4 (*a*) would have resulted. If the sample had been so prepared that it corresponded in its ends to Fig. 3, but the top pick was the tenth pick of Fig. 3, the weave obtained would be as shown in Fig. 4 (*b*). Again, if the sample had been so prepared that the eleventh end of Fig. 3

was the first end of the sample and the fourteenth pick the top pick, the pick-out would have resulted as shown in Fig. 4 (*c*). If these three weaves are examined carefully, it will be seen that although the weaves are apparently different from one another and from Fig. 3, they are all in reality exactly alike, since if repeated several times in the cloth, the same effect will be produced, the difference in their appearance being due only to the end and pick on which the pick-out is started.

After having obtained a pick-out of a greater number of ends and picks than is actually necessary to show one repeat of the weave, it is always best to so select the ends and picks for a repeat that the weave will have the appearance that it naturally would if constructed by a designer. Thus, if one repeat of the weave, as shown by the filled squares in Fig. 3, be compared with one of the weave shown by the filled squares in Fig. 4 (*c*), the lack of a logical and natural arrangement of the weave is very noticeable in the latter as compared with the former. The impression conveyed by Fig. 3 is that the weave is a simple check weave, consisting of four equal sections of 6 ends and 6 picks each. It is also apparent that in the upper left-hand and lower right-hand sections the filling predominates on the face of the cloth, while in the upper right-hand and lower left-hand sections the warp predominates. No such impressions are conveyed by the repeat of the weave as shown in Fig. 4 (*c*), nor is the arrangement of the weave as clear, even in Fig. 4 (*a*) and (*b*), as in Fig. 3. It will thus be seen that there are advantages in selecting the most suitable end and pick as the first end and the first pick of a weave, and especially is this true in weaves that are combinations of two or more simple weaves.

There are several points that may be learned from the weave of the sample under consideration. In the first place, it will be noticed that this weave is an evenly balanced check; that is, the total area of 12 ends and 12 picks occupied by the weave is divided into four areas of 6 ends and 6 picks each. The check is obtained by transposition and cuts perfectly; that is, the warp floats of one section

oppose the filling floats of the adjacent sections and vice versa. When the yarns used are colored as in the sample under consideration, this weave produces what is sometimes known as a *star check*.

It should not be thought that every sample of cloth is made up of a weave design, or combination of weaves, as in the case of this sample; many cloths consist of simply one weave.

HARNESS, OR DRAWING-IN, DRAFTS

13. The **harness draft** indicates the order in which the warp ends are drawn through the harnesses. When making it, each end that interlaces with the filling in a different manner from other ends must be drawn in on a separate harness. As a result, as many harnesses will be required for any given weave as there are ends having different interlacings.

By carefully examining each end in one repeat of the weave obtained from the cloth under consideration, it will be seen that of the 12 ends in the weave all have different interlacings with the filling except the fifth and sixth ends, which are alike, and the seventh and eighth, which are also alike. The fifth and sixth ends, therefore, could be drawn in on the same harness, since they work exactly the same; this is also true of the seventh and eighth ends. But as this would make an irregular drawing-in draft and result in the saving of only 2 harnesses, it is best to draw the warp through the harnesses straight for this fabric. This will make a straight drawing-in draft on 12 harnesses, as shown in Fig. 5.

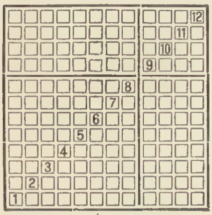


Fig. 5

The horizontal rows of squares in Fig. 5 represent the harnesses, while the figures in the draft show on which harness each end is drawn in. In making out the drawing-in draft, commence with the first end of the weave at the left and draw it in on the first harness. The second end of the weave must in this case be drawn in on a separate harness, as it has different interlacings from the first end, and so is

drawn on the second harness as indicated. Proceed in the same manner with each end of the weave in succession, always working from left to right.

14. If any end in a weave has interlacings exactly the same as the interlacings of any other end in the weave, it may be drawn in on the same harness, in which case the same number of harnesses as ends in the weave will not be required. However, as explained previously and illustrated by the weave under consideration, it is sometimes desirable to use more harnesses than are absolutely necessary, because of the increased simplicity of the drawing-in draft thereby obtained. The drawing-in draft will always occupy the same number of ends as one repeat of the weave, but if more than one end is drawn on any harness it is evident that the same number of harnesses as ends in the weave will not be used.

It should be borne in mind that the color of the ends does not make any difference in the manner of drawing each end through the harnesses, the only distinction being the manner in which the end interlaces with the filling, except that in some cases, where there is a fancy thread in a design, these threads are all drawn on one harness if possible. Many weaves may be drafted down to a very small number of harnesses, but this is not always advisable, as in many cases the draft will become so complicated that the weaver will have considerable trouble in drawing in a broken end on the correct harness. Then, again, if the whole warp is drawn in a small number of harnesses, especially in goods having a large number of ends per inch, the heddles on the harnesses become so crowded that the ends break much oftener, owing to the chafing that results from operating the harnesses when they are crowded. In many cases other circumstances will be found that influence the number of harnesses on which a weave or combination of weaves is woven. A student of designing should constantly seek information on these points, especially in a weave room where there is an opportunity of examining samples of cloth from the various fabrics and of knowing how they are woven. He may then

find, by analysis, the lowest number of harnesses on which it is possible to weave the sample, and also the actual number of harnesses on which it is being woven in the weave room. If more harnesses are used than the lowest number possible, the reason should be learned. With many weaves it will not be possible to tell at a glance the number of harnesses necessary, as was the case with the weave in the sample of cloth under consideration. Such weaves must be carefully examined and the interlacings of each end studied separately, in order to determine which ends have similar interlacings.

15. When making out the harness, or drawing-in, draft for any weave, the following particulars should be noted in each case: (1) It is always desirable to make out a harness draft in such a manner that it will be as nearly a straight draw as possible; this is a great aid to the weaver when drawing in broken ends, as he can thus find the proper harness more readily. (2) Try to have the same number of ends on each harness; this is a great aid to the smooth and easy running of the loom, as it equalizes the strain on each harness. (3) If it is necessary to place more ends on some harnesses than on others, try to have these harnesses at the front, as the majority of broken ends will occur on these harnesses and, if they are at the front, the ends are much more easily tied in. The front harnesses also are easier on the yarn, since they are not lifted as high in shedding as the other harnesses.

CHAIN DRAFT

16. The **chain draft** is obtained from the weave and drawing-in draft, and therefore these must first be obtained. By referring to Fig. 5, which shows the harness draft for the weave under consideration, it will be seen that the first end in the weave is drawn in on the first harness; therefore, the interlacings of the first end must show the working of the first harness; or in other words, the interlacings of the first end show the manner of raising the first harness. The

second end is drawn through the second harness; therefore, the interlacings of the second end as shown in the weave illustrate the manner in which the second harness is raised. The same method is continued throughout, proceeding in regular order, as this is a straight draft. However, where a weave is drafted to a lower number of harnesses than there are ends in the weave, that is, where the drawing-in draft is not straight and more than one end is drawn in on any harness, that harness will control two or more ends of the weave; but in the chain draft only one of these ends will be needed to govern the method of raising the harness. Consequently, when obtaining the chain draft, begin at the left of the weave and take only those ends that are drawn in on different harnesses, taking each end only once. In the weave under consideration, each end is drawn in on a different harness; therefore, each end will have to occur in the chain draft as shown in Fig. 6, which in this case is the same as the weave, or pick-out, in Fig. 3, in consequence of the drawing-in draft being straight. When the harness draft is not straight, the chain draft becomes a reduced weave—reduced according to the harness draft.

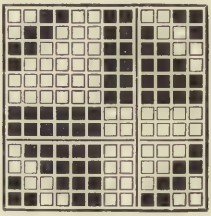


FIG. 6

ADDITIONAL POINTS TO BE DETERMINED BY ANALYSIS

17. In addition to the requirements listed in Art. **2**, there are a few other items that must in most cases be determined when analyzing a fabric. Some of these are unnecessary in themselves, but must be ascertained in order that other items may be accurately found. They are as follows: (1) determination of the face and back of the fabric; (2) determination of warp and filling; (3) determination of the direction of twist in warp and filling; (4) the shrinkage of the cloth; (5) the number of beams necessary; (6) the raw material.

DETERMINATION OF FACE AND BACK OF FABRIC

18. The face and back of a fabric must always be decided on before finding the pick-out, in order that the correct weave may be obtained. In most fabrics this is easily done, although some cloths baffle the most experienced designer. The face of a worsted fabric that has a prominent design will be found to show a much clearer and better pattern than the back. The finish on the face side is also better in practically every case, the cloth being generally sheared or singed closer; it will also be more lustrous, since it receives more brushing and attention in the finishing. Often the back of such a cloth will show more or less loose fibers, while the face will be devoid of the same. Often the effect of the weave is such that the face of the fabric is readily determined. When a fabric is a backed or a double cloth, the face can often be distinguished by the style of the finish. The backing yarns in a double cloth are also frequently coarser and of poorer quality than the face yarns. In a filling-backed fabric, the backing filling floats on the back of the cloth and is generally a soft-twisted yarn, in order to give the cloth a warm feeling. Warp-backed fabrics have long floats of the backing warp floating on the back of the cloth, and therefore the face is readily determined.

When a fabric has a stripe design, the stripe usually shows up more prominently and has a more finished appearance on the face of the fabric. In milled and napped fabrics, the face of the cloth is mostly smoother and more lustrous than the back, and the nap is generally brushed in one direction and sheared to an even length, thus making a smooth and velvety surface on the face of the goods.

DETERMINATION OF WARP

19. There are several methods by which the warp may be distinguished from the filling: (1) If the sample submitted for analysis contains a part of the selvage, the warp can be readily distinguished from the filling, since the selvage always runs in the direction of the warp. (2) If in any

fabric one series of yarn is found to be harder-twisted—that is, has more turns of twist per inch—than the other series, the former will in all probability be the warp, because harder-twisted yarns are stronger and it is customary to use them where the most strain occurs, which is always in the warp. (3) If the sample has been gigged and a fairly long nap raised on the cloth, the direction of the nap will always indicate the direction of the warp, since all cloth, in being finished, is passed through the finishing machines in the direction of the length of the piece, or the warp. (4) The counts, or number, of the yarns will often indicate which series of yarn is warp and which is filling, since in many cases the filling will be of finer counts than the warp. However, the student should not assume that this is true in every instance. (5) If in any case one series of yarn is found to consist of threads of different materials, such as worsted and cotton, while the other series of yarn is all of one material, the former is generally the warp, although this is not an invariable rule. (6) If the sample of cloth submitted for analysis contains reed marks, these marks will indicate the warp, since they always run warpway of the goods. They are caused by the reed wires becoming bent or getting out of place, thereby crowding some ends together and giving others too much space. (7) Any fabric of a striped character, such as trouserings, etc., will usually indicate the warp at once, as the stripe nearly always runs in the direction of the warp. (8) If the design is a twill, it generally runs up to the right, thus indicating the warp. This, however, is not an invariable rule, as many cloths are twilled to the left. (9) If one series of yarn is composed of ply yarn and the other series of single yarn, the ply yarn may usually be considered the warp and the single yarn the filling. In woolen cloths, however, ply yarns are frequently used in the filling. (10) In union fabrics in which one series of yarn is all cotton, this series is generally the warp yarn.

DETERMINATION OF TWIST

20. By the term **twist** both the direction of the twist and the amount of twist, or number of turns per inch, placed in the yarn is meant. The direction of the twist of yarn becomes an important matter when reproducing cloth, since with some weaves a different effect will sometimes be obtained by simply changing the twist of the warp or the filling. Yarns may be twisted in one of two directions, which are technically known as *right twist* and *left twist.* There is considerable difference of opinion as to what constitutes a right-twist or a left-twist yarn, as some mills consider as right-twist what other mills consider as left-twist yarn. However, the method of indicating the twist that is most commonly applied will be explained here.

By holding the thread between the thumb and forefinger of each hand the direction of the twist may be easily learned. If, when turning the yarn from the body with the right hand, it is untwisted, it is right-twist; if it is twisted up harder, it is left-twist. Another method of determining the twist of the yarn is to observe which way the twist marks on the surface of the thread are inclined when the thread is held upright. If they slant up to the left, the yarn is left-twist; if up to the right, it is right-twist. This is the method adopted with screws for determining the twist of the screw thread. Fig. 7 represents a yarn that would be known as a right-twist yarn, while Fig. 8 illustrates a left-twist yarn. By closely examining the yarn in the sample under consideration, it will be seen that all the yarn in the warp is a 2-ply yarn twisted to the left, or left-twist, while the filling is a single right-twist yarn. The single yarns twisted for the warp thread would be spun right-twist and when folded would be twisted to the left, since the ply yarns are always twisted in the opposite direction to the single yarns of which they are composed.

Fig. 7

Fig. 8

As previously stated, twist also refers to the amount of twist, or the number of turns per inch, in a given yarn.

In the case of a ply yarn this can usually be readily ascertained by putting the yarn under a pick glass; or it can be found with more accuracy by untwisting a given length of yarn and dividing the number of turns of twist by the number of inches measured.

21. Twist Counter.—The amount of twist in any yarn may be determined by means of an instrument made for the purpose of untwisting the yarn and registering the number of revolutions made in taking out all the twist; this instrument is known as a **twist counter**. The simplest and most commonly used form is shown in Fig. 9. It consists primarily of two jaws, one of which *b* is capable of adjustment on a bar *a*; the other jaw *c* may be rotated, the exact

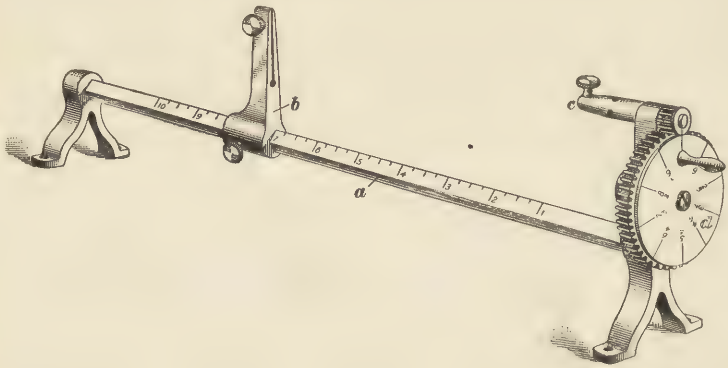


Fig. 9

number of turns that it makes being indicated on a graduated dial *d*. The counter is adapted for finding the number of turns in a sample of yarn from 1 to 10 inches in length, whether right- or left-twist. The yarn is held firmly by the jaws at a given distance apart, as indicated by the position of *b* on *a*; the jaw *c* is then rotated until all the twist is taken out of the yarn, the instrument recording the number of turns on the dial *d*.

SHRINKAGE

22. The shrinkage of the cloth is an item that can be determined only by the experience and the judgment that will come to the student of designing after becoming familiar with various cloths and their peculiarities in finishing.

It must be understood that while it is true that certain goods shrink a given percentage within certain limits, yet there is some leeway, and the finisher can produce goods of any width and weight required within reasonable limits. The shrinkage, of course, varies largely with the raw material as well as with the class of goods; some wools will full up much more quickly than others and thus shrink more. It must be remembered that goods can be shrunk almost any desired amount, depending on the nature of the fabric that is desired.

23. The following table shows the percentages usually allowed for different classes of goods, thus giving an idea of how wide they should be reeded, in order to finish easily to the desired width:

Class of Goods	Percentage of Shrinkage
Beavers	25 to 30
Kerseys	25 to 30
Meltons	25 to 30
Pilots	25 to 30
Doeskins	15 to 20
Cassimeres	12 to 15

Woolen goods shrink more than worsted goods and consequently should be reeded wider and warped longer for the same finished width and length. Goods that are fulled also shrink more than goods that are not fulled. Heavy woolen goods with heavy fulling, such as triple-milled goods, will sometimes shrink as much as 30 per cent. and will average from 25 to 30 per cent. For light-weight, fulled

woolens a shrinkage of from $12\frac{1}{2}$ to 18 per cent. in the width should be allowed, while if not fulled a smaller allowance, say from 10 to 15 per cent., is sufficient. As a general rule goods do not shrink so much in length as in width, especially those that are not fulled, the action in passing through the finishing machinery being to keep the goods stretched in length.

For light-weight worsted goods with a clear finish from 8 to $12\frac{1}{2}$ per cent. shrinkage in width is sufficient to allow, while if fulled (which is rarely done) from $12\frac{1}{2}$ to 15 per cent. should be allowed. For heavy-weight worsted goods with a clear finish from $12\frac{1}{2}$ to 15 per cent. shrinkage in width should be allowed, while if the cloth is fulled an allowance of 15 to 20 per cent. should be made.

Goods made with cotton warps do not shrink in length, and those with cotton filling do not shrink in width, to so great an extent. Goods with a mixture of cotton and wool, either in warp or filling or both, shrink proportionately less than goods made from pure wool. When it is desired to estimate the shrinkage of a fabric from a small sample, a thread of a given length, say 2 inches, may be pulled out, moistened a little, and then stretched (but not too hard) and measured again. The amount that the thread stretches will give some indication of the amount that the fabric has shrunk. This may be done with both warp and filling.

NUMBER OF BEAMS REQUIRED

24. Although the majority of cloths are woven from one beam, yet in many cases, when desiring to reproduce a fabric, it will be found necessary to use more than one beam for the warp yarn, in order to allow for the difference in the take-up of a portion of the warp yarn. When dissecting any cloth, in order to decide this, the weave should be carefully considered. If the cloth is made from one regular weave and the warp yarn is all the same, it will be necessary to use only one beam; but in cases where two or more weaves are combined in a fabric, it will be necessary to study the

weaves carefully and ascertain whether one will take up more than the other.

When desiring to find the number of beams necessary to weave any sample of cloth, the most essential point to notice is the interlacings of each weave. For instance, the ends of one weave may interlace with the filling six times in a certain number of picks, while the ends of another weave in the same design may interlace twelve times in the same number of picks. When such is the case, the ends that interlace the larger number of times will, of course, take up faster, owing to the fact that they bend around the filling more times. If a warp for a cloth like this is placed on one beam, those ends that take up more rapidly will grow tighter in the fabric, thus giving it a cockled appearance. In such instances it will be found best to separate the ends that do not take up alike and place them on two beams. It is unnecessary to use two beams, unless there is a marked difference in the take-up, since small differences will be overcome by the elasticity of the yarn.

In some cases a cloth may be regular, therefore apparently requiring only one beam, with the exception that at certain intervals there will be a fancy thread that will have different interlacings from the body of the cloth, in order that it may produce some desired effect. In this case the fancy threads are placed on a separate beam or, if there are only a few, they are wound on a jack-spool, which may be adjusted at the back of the loom.

Double cloths and cloths backed with warp often require two beams, one for the face warp and one for the back warp, since the back weave is generally different and also because coarser yarns are used for the back of the fabric. If the same yarn and weave are used for the back as for the face of a double cloth, both warps can be put on one beam.

DETERMINATION OF RAW MATERIAL

25. In many fabrics there will be a mixture of different materials; for instance, woolen and cotton yarns, worsted and cotton, woolen and silk, worsted and silk, and other

combinations are often found in the same fabric. In such cases it will be found necessary to determine which ends are of one material and which ends are of another. A knowledge of the different fibers is of great aid in determining of what material various yarns are made, but often a single yarn may be composed of several materials, the mixture having been made in the raw stock. In this case chemical or microscopical tests must be used, in order to determine the different materials and the percentage of each.

The quickest, and an invariable, method of ascertaining whether a sample is composed of animal or vegetable fibers is to burn a sample of the yarn. Vegetable fibers are composed of carbon, hydrogen, and oxygen, and when burned will make a flame and leave a white ash, but will emit no odor. Animal fibers are composed of the same elements as vegetable fibers, but also contain nitrogen and, in the case of wool, sulphur to a small extent; when burned, they will not flame but smolder, coiling up and forming a small, crisp globule. They are also distinguished from the vegetable fibers by the peculiar odor, similar to that of burned horn or feathers, that they emit while burning.

26. Distinguishing Woolen From Worsted Yarn. To distinguish a woolen yarn from a worsted yarn, untwist the yarn and observe the disposition of the fibers in the structure of the thread. A worsted yarn is a thread composed of wool, the fibers of which lie smoothly in the direction of the thread and are parallel to each other. The surface of a worsted thread is comparatively smooth and the thread generally has a well-defined luster. A woolen yarn is also a thread spun from wool, but the individual fibers are mixed and crossed in every conceivable direction and the surface of the thread presents a uniformly rough appearance, which, however, is lacking in luster.

As a further test in distinguishing between woolen and worsted yarns, the length of the fibers that compose the thread may be observed. Fibers from a woolen yarn are usually quite short, while those from a worsted yarn are

longer. This test alone gives not sufficient data on which to base an authoritative statement, because some woolen yarns are composed of rather long fibers, while certain worsted yarns are made of comparatively short fibers; it serves, however, as a further indication to supplement the deductions of other tests. The woolen fiber is also crinkled and curled, while the fiber in a worsted thread has a straight appearance.

27. Distinguishing Silk From Other Yarns.—Silk can generally be distinguished from either cotton, woolen, or worsted by its incomparable luster, and also by the fact that it is generally finer. However, mercerized cotton, which also has a remarkable luster, should not be confounded with silk. These two yarns may be distinguished by burning, as the silk, being an animal fiber, will burn similarly to wool.

28. Distinguishing Linen From Cotton.—Linen may be distinguished from cotton from the fact that the thread is rougher and contains uneven bunches. Linen may also be distinguished from cotton from the fact that it has a harsher feeling.

29. Ascertaining the Percentage of Each Material in Union Fabrics.—Tests have been given by means of which it should be possible to distinguish the fibers that are ordinarily met with in textile fabrics, but nothing has been said about the quantity. Where different materials are placed in a fabric in solid threads of each material it is a simple matter to determine the amount of each material, but when the different materials are mixed in the raw stock it is more difficult to find the exact percentage of each. For instance, many woolen yarns, especially warp yarns in low-grade goods, contain cotton, which not only cheapens the fabric, but makes the yarn stronger. To determine the percentage of cotton, or other vegetable fibers, in a mixed yarn composed of animal and vegetable fibers, the following method may be employed: If accurate results must be obtained, the yarn or cloth sample in which the percentage

of wool and cotton, or other animal and vegetable fiber, is to be determined should first be stripped of dye stuff by being boiled in dilute hydrochloric acid. The yarn or cloth is then immersed for 20 minutes in ammoniacal copper oxide or concentrated sulphuric acid, which destroys the vegetable matter. The fibers that are left when dried and weighed will give the percentage of wool, or other animal fiber, as compared with the weight of the original sample.

30. A method that is used perhaps more frequently than the above is to boil the weighed sample in an 8° B. solution of caustic potash for 2 hours, after which it is washed and dried. During the boiling, a few drops of water are added from time to time to prevent the alkali from becoming too concentrated. After the sample is dried, its weight will be that of the cotton in the sample and the loss in weight will be that of the wool. Instead of potash, a 7° B. solution of caustic soda may be used, the boiling being carried on for not over 15 minutes.

NOTE.—B. means Baumé and refers to the graduated scale on Baumé's hydrometer used for determining the density of a solution.

31. To separate silk, cotton, and wool: Take two samples each of the same weight; boil them from 15 to 30 minutes in a 3° B. solution of hydrochloric acid to remove the sizing, etc.; then wash them. Immerse one sample in a boiling solution of basic zinc chloride for a short time; then wash thoroughly first in acidified and then in clean water, and dry it. The loss in weight gives the amount of silk. Boil the second sample for 15 minutes in a 7° B. solution of caustic soda and then wash and dry it. The residue is cotton, to the air-dry weight of which must be added about 5 per cent. to compensate for the loss of the fiber during the operation. The difference between this and the original weight represents the weight of wool.

TWILL WEAVES AND DERIVATIVES

TWILL WEAVES

GENERAL CONSIDERATION

1. Introductory.—Certain weaves, because of the similarity of their construction and of the effects that they produce in the fabric, are grouped in classes. They partake of the nature of fundamental, or standard, weaves, not only on account of the simplicity of their construction, but also because of their wide and varied use in almost every class of textile fabrics. For instance, the plain weave may be considered as a standard construction, since it is widely used in weaving fabrics composed of any material. One of the largest of these classes is that of **twill weaves,** which are so called because of the peculiar effect they form on the surface of the fabric. Many of the simpler twills have, like the plain weave, acquired distinctive names by which they are readily recognized by experienced designers.

2. Construction of Twills.—In the plain weave, each end is alternately raised and lowered, but in a twill the warp ends are so raised that the warp and filling floats form diagonal lines across the cloth, known as *twill lines.* In a twill each warp end must be either over or under the filling for at least 2 picks in succession and at least 2 successive warp ends must be raised or lowered on each pick, in order to make the twill line across the cloth. On this

account at least 3 harnesses are necessary to weave a twill, or in other words three is the smallest number of harnesses on which a twill effect can be formed in the cloth. Thus, the *3-harness*, or *prunelle, twill*, as it is called, is the simplest twill that can be made.

As shown in Fig. 1, the first end of this weave is down on the first pick, but floats over the second and third picks; the second end is down on the second pick but floats over the third and first picks; the third end is down on the third pick but floats over the first and second picks. Each end in this weave therefore floats over 2 picks in succession. This constitutes one repeat of the weave; that is, if the fourth end were shown, it would be found to be similar to the first end, while the fifth end would be like the second, and the sixth like the third. It will also be noted in Fig. 1 that on the first pick the second and third warp ends are raised, on the second pick the first and third warp ends are raised, and on the third pick the first and second warp ends are raised. Thus it will be seen that in this weave all the requirements of a twill weave are met. With this weave a twill, or diagonal, line is formed running up to the right. Weaves may be twilled either to the right or to the left, although in the majority of cases they are so constructed as to form twill lines running up to the right, as in the case of Fig. 1. Fig. 2 shows a warp-flush prunelle twill running to the left.

FIG. 1

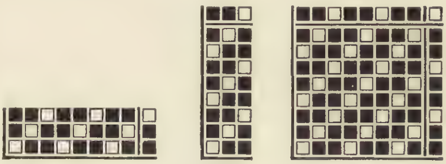
FIG. 2

FIG. 3

3. A weave may be *warp flush*, *filling flush*, or *equally flush*, depending on whether a preponderance of warp or filling or an equal amount of each is brought to the face of the cloth; thus, Fig. 1 is a warp-flush prunelle twill, while Fig. 3 shows a filling-flush prunelle twilled to the right and Fig. 4 shows a filling-flush prunelle twilled to the left. A cloth woven with a warp-flush weave shows a filling-flush weave on the back, and if woven with a filling-flush weave shows a warp-flush weave on the back. Thus it will be seen that these terms simply refer to the effect on the face of the cloth.

FIG. 4

4. Repeat of the Weave.—One of the most important things in designing and probably one of the most difficult for the beginner to understand is the repeat of the weave; especially is this of importance in dealing with twills. It will be found a great aid, when only one repeat of a weave is given, to practice extending the weave on design paper for several repeats. By this means one repeat of any weave will more readily be found when it becomes necessary to distinguish a single repeat from several repeats. Weaves may be repeated on design paper either in their ends or in their picks, or they may be repeated in both the ends and the picks. Suppose, for example, that it is desired to extend Fig. 1 for three repeats in its ends. As already stated, this weave is complete on 3 ends; consequently, three repeats will occupy three times this number, or 9 ends. If it is desired to repeat the weave in its picks three times, it will occupy 9 picks; while if it is repeated three times in both ends and picks, it will occupy 9 ends and 9 picks.



(*a*) (*b*) (*c*)

FIG. 5

When repeating a weave it is simply necessary to copy the weave exactly as it is; that is, if Fig. 1 were to be repeated in its ends, one repeat of the weave would first be set down and the other repeats copied. The fourth end would be the same as the first; the fifth end, the same as the second; and the sixth end, the same as the third. This would make two repeats. If another repeat is required, the ends will simply be copied again in their proper order. If the weave is to be repeated in its picks, the picks will be copied in the same manner as were the ends when repeating in its ends. Fig. 5 (*a*) shows the weave Fig. 1 repeated three times in its ends; Fig. 5 (*b*) shows the weave repeated three times in its picks; and Fig. 5 (*c*) shows the weave repeated three times in both ends and picks.

REGULAR TWILLS

5. Regular twills are those that run in regular order; it is, therefore, simply necessary to know the interlacing of any one end or pick, say the first, of a regular twill in order to show the entire weave on design paper.

The interlacings of the first end or pick of any regular twill are conveniently shown by writing numbers above and below a horizontal line; thus, for example, $\frac{2\quad 1\quad}{\quad 3\quad 2}$ shows that the first end is up 2 picks, down 3, up 1, and down 2. The interlacing of a regular twill weave shown in this manner is called the *base* of the twill. Since in regular twill weaves the ends interlace with the picks in exactly the same manner as the picks interlace with the ends, the base also shows the interlacing of the first pick, as it indicates that on the first pick the first 2 ends are up, the next 3 are down, the next 1 is up, and the next 2 are down. The sum of these numbers, eight, shows that the twill repeats on 8 ends and 8 picks.

Suppose that it is desired to show the $\frac{2\quad 1\quad}{\quad 3\quad 2}$ twill on design paper. The first step is to mark the first end or first pick in the manner indicated by the base; the twill will be the same whichever is marked. If the first end is marked, it should be marked from top to bottom; if the first pick, it should be marked from left to right. One method, however, should be adopted; consequently, the system of marking the first pick will be used here. Marking this pick shows that the first 2 ends are up, the next 3 ends down, the next end up, and the next 2 ends down, as shown in Fig. 6. The next step is to run up the twill in regular order; that is, if an end is up on one pick, on the next pick the next end in the direction in which the twill is to run is up.

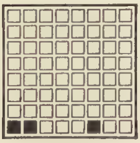


FIG. 6

That this method of making a twill may be more readily understood, each end will be run up separately and afterwards the complete design will be shown. Commencing with the first end and the first pick, which is at the lower left-hand corner, this first end is raised on the first pick; then

on the next pick the next end to the right, if the twill is run to the right, will be raised; that is, the second end will be raised on the second pick, and the third end will be raised on the third pick. This is continued for the 8 ends and 8 picks with the result shown in Fig. 7.

Next taking the second end and dealing with it in exactly the same manner will give the result shown in Fig. 8. It should be noted in connection with this figure that when running these marks up on the design paper the eighth end is raised on the seventh pick. If this were continued in a regular line for the 8 picks, the next mark would come on the ninth end, but the weave is complete on 8 ends; consequently, the mark for the ninth end is placed on the first end, since the ninth end will be the first end of the next repeat, which of course is exactly like the first end of the repeat under consideration. That this is correct will be seen if two repeats of the weave are made.

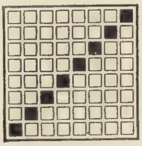


Fig. 7

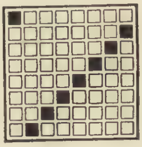


Fig. 8

In Fig. 6, the third, fourth, and fifth ends are lowered on the first pick; these blank squares will consequently run up in the same manner as the filled-in squares, but it is not necessary to consider them since, if the filled-in squares are run up correctly, the blank ones must be correct. Since the sixth end is raised on the first pick, the seventh end will be raised on the second pick and so on, as shown in Fig. 9. It should be noted that the eighth end is raised on the third pick and that in order to continue for the 8 picks, the first end must be raised on the next pick and the marks run from this point to complete the 8 picks, as shown. As the seventh and eighth ends are down on the first pick it is not necessary to consider these. If Figs. 7, 8, and 9 are combined, the complete twill will be obtained, as shown in Fig. 10. When constructing a twill, it is not necessary to run up each twill line

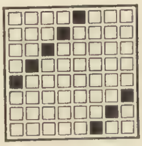


Fig. 9

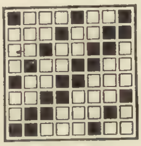


Fig. 10

separately as in Figs. 7, 8, and 9 and then combine them as in Fig. 10 since it is perfectly feasible to construct the entire twill as shown in Fig. 10 at one operation. The method of running up each twill line separately is adopted only to explain the construction of the complete twill.

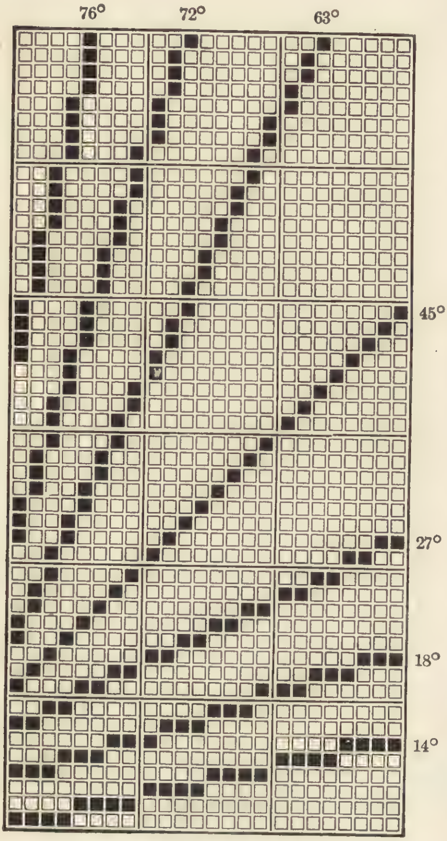


FIG. 11

6. A rule for making any regular twill when the interlacings of the first pick are given is as follows:

Rule.—*Mark on the first pick of the weave the ends that are to be lifted on that pick; then above on the second pick place similar marks, moving them one square to the right if the twill is to run to the right, or one square to the left if the twill is to run to the left. Proceed with each pick in the same way, moving one to the right or left, as the case may be, until there are as many picks as ends, when the weave will be completed.*

7. Angles of Twills.—The angle of a twill is affected: (1) by the manner in which the ends and picks interlace; (2) by the relative number of ends and picks per inch.

Fig. 11 illustrates the method of running up twill lines on design paper so as to form different angles.

In the first twill line at the bottom, the twill moves four squares filling way, or across the design, and then one square up; by this means an angle of 14° is formed. In the next case the twill moves three squares filling way and then one square warp way, forming an angle of 18°. In the next case the twill moves two squares filling way and then one warp way, which gives an angle of 27°. By carefully noting each twill line, the method of forming different angles will be readily understood. Twills are spoken of as being such a degree twill, the 45° twill being the most common, as it is the angle formed by all regular twills.

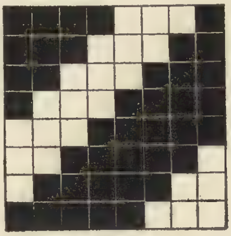


Fig. 12

A twill that forms a certain angle on regular 8 × 8 design paper will not form that same angle in the cloth unless the number of ends and picks per inch and the counts of the warp and filling yarns are the same. For example, the 45° twill shown in Fig. 12 is shown on 8 × 8 design paper; that is, the design paper has eight vertical rows of squares and eight horizontal rows in the same distance, warp or filling way. Since a row of squares across the paper represents a pick and a row of squares vertically represents a warp end, a twill or any design on this kind of design paper shows the weave as it would appear in the cloth if the same number of picks per inch as ends per inch is inserted. Suppose that twice as many picks are placed in 1 inch of the cloth as there are ends per inch; then in order to give a correct representation of this on design paper, a paper should be used that contains twice as many horizontal rows of squares in a given space as it has vertical rows of squares. Fig. 13 shows the twill in Fig. 12 on design paper of this kind; it will be noticed that an angle of 27° is formed. On the other hand, if there are twice as many ends per inch in the cloth as there are picks, an angle

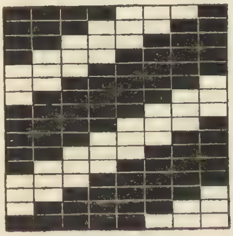


Fig. 13

of 63° will be formed with this same twill; Fig. 14 illustrates this point. It will be noticed that in both Figs. 13 and 14 two repeats of the weave are shown. Ordinarily, however, 8 × 8 design paper is used in constructing designs even if the fabric is to be woven with more picks than ends per inch or vice versa. It is only in jacquard designing and for some

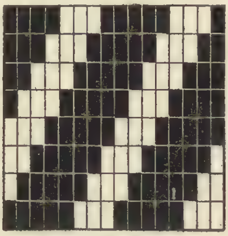


Fig. 14

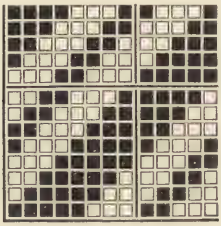


Fig. 15

special fabrics where it is desired to preserve the symmetry of a figure, or pattern, that a design paper is used corresponding to the relative number of ends and picks per inch in the fabric.

When working out twill weaves on design paper it should be understood that whatever kind of twill the weave may be, the

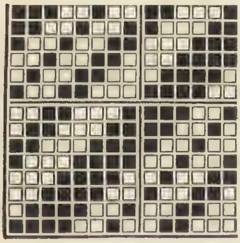


Fig. 16

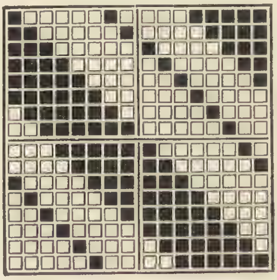
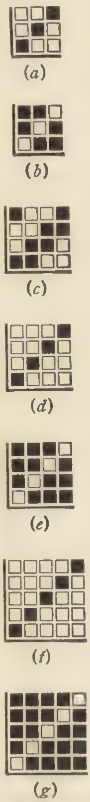


Fig. 17

marks or blanks for one repeat should not be extended beyond the number of ends and picks that has been decided on. For instance, if one repeat of the weave occupies 4 ends and 4 picks, the fifth end would be like the first, and so on; also the fifth pick would be like the first pick, and so on. Consequently, to

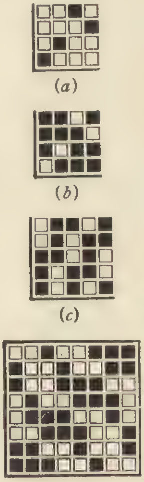
show one repeat only 4 ends and 4 picks are necessary. All regular 45° twills repeat on the same number of picks as ends, so that if the base of such a twill occupies 12 ends, it repeats on 12 ends and 12 picks. Twills that form an angle of more than 45° are known as *upright twills*, while those that form an angle of less than 45° are called *oblique*, or *reclining*, *twills*.



(a) (b) (c) (d) (e) (f) (g)

FIG. 18

8. By carefully studying the following regular 45° twills and the explanations previously given, a good understanding of the method of working out twills may be obtained. Fig. 15 is a regular 45° twill $\frac{5}{3}\frac{2}{3}$ twilled to the right; Fig. 16 is a regular 45° twill $\frac{4}{2}\frac{1}{2}\frac{2}{3}$ twilled to the right; Fig. 17 is a regular 45° twill with the base $\frac{1}{5}\frac{6}{4}$ twilled to the left. Several twills that are constantly used in the construction of the more common fabrics are known by definite names. Among them are the *filling-flush prunelle*, Fig. 18 (*a*); the *warp flush prunelle*, Fig. 18 (*b*); the *cassimere*, Fig. 18 (*c*); the *filling-flush crow*, Fig. 18 (*d*); the *warp-flush crow*, Fig. 18 (*e*); the *filling-flush Albert twill*, Fig. 18 (*f*); the *warp-flush Albert twill*, Fig. 18 (*g*); the *filling-flush broken crow*, Fig. 19 (*a*); the *warp-flush broken crow*, Fig. 19 (*b*); the *Venetian twill*, Fig. 19 (*c*); and the *Mayo*, or *Campbell*, *twill*, Fig. 19 (*d*). The weaves shown in Fig. 19 are not regular twill weaves but are weaves that are well known.



(a) (b) (c) (d)

FIG. 19

EXAMPLES FOR PRACTICE

1. A regular 45° twill is arranged $\frac{2}{1}\frac{1}{2}\frac{3}{1}$; show the complete weave on design paper.

2. State what angle the above twill would form in the cloth if woven with 54 ends and 27 picks per inch, using the same counts of warp and filling.

3. Show two repeats in both ends and picks of a regular 45° twill having the first pick arranged $\frac{3}{3}\frac{1}{1}$.

4. State what angle the twill given in answer to question 3 would form in the cloth if woven with 30 ends and 60 picks per inch, using the same counts of warp and filling.

DERIVATIVES OF TWILL WEAVES

9. Derivatives Formed by Rearranging Ends or Picks.—The number of what may be termed fundamental weaves is comparatively small, but the weaves that may be derived from them are innumerable. Thus, if a simple twill weave is shown on design paper, several other weaves may be obtained from it by rearranging either the ends or the picks. Designs thus obtained are termed **derivatives.**

To illustrate how derivative weaves are obtained, a regular 45° twill, Fig. 20, is taken and three other weaves formed from it. Suppose that it is desired to form a derivative weave by rearranging the ends of Fig. 20 in 1, 4, 7, 2, 5, 8, 3, 6 order; that is, the first end of the new weave is to be like

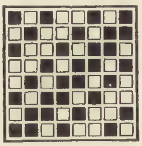


Fig. 20

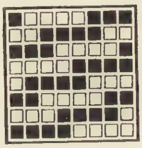


Fig. 21

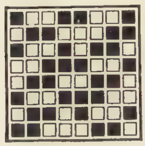


Fig. 22

the first end in Fig. 20, the second end of the new weave like the fourth end of Fig. 20, the third end like the seventh, the fourth like the second, and so on. It will be seen that commencing with the first end of Fig. 20, every third end is taken until by this method the first end is reached again, when the design commences to repeat. Fig. 21 shows the twill in Fig. 20 rearranged in this order.

Suppose that it is desired to arrange the ends in the twill in Fig. 20 in 1, 2, 5, 6, 3, 4, 7, 8 order. Fig. 22 shows that the first and second ends are like the first and second ends in Fig. 20; that the third end is like the fifth in Fig. 20; the fourth is like the sixth; the fifth like the third, and so on.

These two examples show that a number of weaves may be obtained from a regular twill weave, or in fact from any weave. After deriving a weave from a twill still other weaves may be obtained by rearranging the ends of the derivative.

When a weave is to be rearranged in its picks, the same process is employed as when rearranging the ends. Suppose, for example, that it is desired to rearrange the picks of Fig. 20 by taking the first 3 picks, missing the next 3, taking the next 3, and so on until the weave repeats. Fig. 23 shows the twill in Fig. 20 rearranged in this manner; the first 3 picks of Fig. 20 are copied for the first 3 picks of Fig. 23; the next 3 picks of Fig. 20 are skipped; the next 3, that is the seventh, eighth, and first, are copied for the fourth, fifth, and sixth picks of Fig. 23; and so on until the weave repeats.

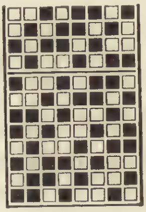


FIG. 23

In rearranging any weave in either its ends or picks, the repeat becomes an important matter and should always be carefully considered. Taking, for example, Fig. 23, it will be noticed that the first pick of this figure is like the first pick of Fig. 20, and also that in working out this new weave the sixth pick of Fig. 23 will be the same as the first pick, but the weave does not repeat on this pick, since the next pick, the seventh, is not like the second. However, after working out 12 picks, the weave repeats, since the next, or thirteenth, pick is like the first, the fourteenth like the second, the fifteenth like the third, and so on.

10. In selecting an order by which to rearrange either the ends or the picks of a weave, care should be taken to select one that will cause the weave to repeat correctly. For example, suppose that it was attempted to rearrange the ends of an 8-end twill by moving in twos; that is, taking one and skipping one; the order would be 1, 3, 5, 7, when it would come back to 1 again and continue in the same order. This, of course, would be a repeat in a certain sense of the

word but would not be a repeat of the weave, since all of the ends of the original weave would not be used.

When it is desired to learn in what order the ends may be taken to make the weave repeat when rearranging the ends or picks of a weave by means of taking one end and skipping a certain number, find two numbers that, when added together, will equal the number of ends or picks on which the weave is complete but that cannot be divided into each other or into the number of ends or picks of the weave without a remainder. When twills are rearranged in this manner they are said to be rearranged in *satin order*.

Suppose that it is desired to rearrange the ends of a twill that is complete on 12 ends and 12 picks. It will be seen that 7 and 5 are two numbers that cannot be divided into each other or into 12 without a remainder but that when added together will equal 12. Therefore, the ends of the weave may be rearranged by moving in sevens or fives. That is, if the ends are arranged on a base of 7, the first end of the weave is copied, while the next six are missed, and so on, which will give the following order: 1, 8, 3, 10, 5, 12, 7, 2, 9, 4, 11, 6; here the weave will commence to repeat and consequently will not need to be continued. On the other hand, take two numbers such as 8 and 4; these added together make 12, but it will be noticed that 4 can be divided into 8 and also into 12. It would not therefore be possible to rearrange a 12-end twill with either of these numbers. To show that this is correct suppose that it is attempted to rearrange the ends of a 12-end weave on a basis of 4, that is, taking the first end and missing the next 3 ends. The order will be 1, 5, 9, and if the next 3 ends are missed it will be seen that it is necessary to take the first end again, when exactly the same ends will be taken, and consequently only these 3 ends will be used, which will not give a repeat of the weave.

11. Derivatives Formed by Combining Twills. Another method of obtaining derivative weaves and one quite generally adopted is that of combining two weaves either in their ends or picks. Suppose that from the two

weaves shown in Figs. 24 and 25 it is desired to form a new weave by combining them pick and pick; that is, first taking a pick of one weave and then a pick of the other, as in Fig. 26. It will be noticed that the first pick of Fig. 26 is the first pick of Fig. 24; the second pick of Fig. 26 is the first pick of Fig. 25; the third pick of Fig. 26 is the second pick of Fig. 24; the fourth pick of Fig. 26 is the second pick of Fig. 25. This is continued until the picks in both Figs. 24 and 25 are all used, when the weave will be complete.

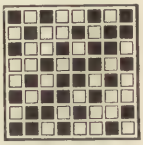


Fig. 24

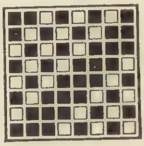


Fig. 25

There are numerous other weaves that may be obtained by combining these two weaves pick and pick. Take for example Fig. 27, which is different from the weave shown in Fig. 26 and yet is obtained by combining Figs. 24 and 25 pick and pick. By carefully noticing Fig. 27, it will be seen that in this case the second pick of Fig. 25, instead of the first, is the first pick taken, as was the case with Fig. 26. Thus, the first pick of Fig. 27 is the first pick of Fig. 24; the second pick of Fig. 27 is the second pick of Fig. 25; the third pick of

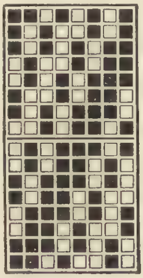


Fig. 26

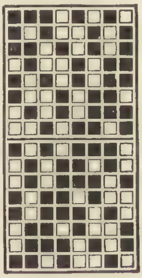


Fig. 27

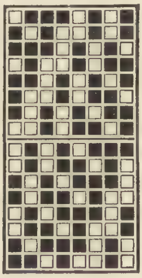


Fig. 28

Fig. 27 is the second pick of Fig. 24; the fourth pick of Fig. 27 is the third pick of Fig. 25; and this is continued until all the picks in both weaves are used, when the new weave will commence to repeat.

Still another weave may be obtained by commencing with the first pick of Fig. 24 but having for the second pick of the new

weave the third pick of Fig. 25. Fig. 28 shows such a weave, and by carefully studying each pick it will be noticed that the first pick of Fig. 28 is the first pick of Fig. 24; the second pick of Fig. 28 is the third pick of Fig. 25; the third pick of Fig. 28 is the second pick of Fig. 24; the fourth pick of Fig. 28 is the fourth pick of Fig. 25; the fifth pick of Fig. 28 is the third pick of Fig. 24; the sixth pick of Fig. 28 is the fifth pick of Fig. 25; and so on until all of the picks in both Figs. 24 and 25 are used, whereupon the weave commences to repeat.

In addition to combining weaves pick and pick, they may also be combined by taking 2 picks of one weave and 1 pick of the other or by taking 2 picks of one weave and 2 picks of the other; or in short, almost any method may be adopted, and consequently the number of weaves that may be obtained is almost without a limit. Weaves should be combined in such a manner that long floats of either warp or filling will be avoided. If the combining of different weaves is practiced, it will be seen that frequently when two weaves are combined by one method long floats will appear, but that by starting on a different pick or by using a different method of combination the same two weaves may be combined without this defect.

12. When combining or copying twills, the natural tendency is to look from the designs to be copied to the design being made; this method occupies considerable time and is liable to cause errors. A better method is to mark the first pick of the twill and then run it up in the same manner as regular twills. When two twills are to be combined in their picks, it is a good plan to indicate on the design paper the picks on which one twill is to be placed and then run up each twill separately, placing each on its own picks.

Though the two weaves that have been combined are complete on the same number of ends and picks, yet it frequently occurs that weaves are combined that are not complete on the same number of ends and picks; in these cases it is important to know when the weave formed by the combination commences to repeat. To illustrate this point, suppose

that it is desired to combine pick and pick an 8×8 twill with a 6×6 twill. When the 8 picks of the first weave have been used, all 6 picks of the second weave will have been used once and in addition 2 of them will have been used the second time; therefore, the weave will not repeat here. When the 8 picks of the first weave have been used twice, the 6 picks of the second weave will have been used twice and 4 of them the third time; therefore, the weave does not repeat as yet. When the 8 picks of the first weave have been used three times, all the picks of the second weave will have been used exactly four times, and consequently the weave will repeat at this point. Thus the first weave will be repeated in its picks three times, making 24 picks, and the second weave will be repeated four times, making 24 picks, and since these two weaves are combined pick and pick the resulting weave will occupy 48 picks.

On the other hand, 24 ends will be occupied by the resulting weave in order to have the weave repeat in its ends. Therefore, any weave formed by combining pick and pick an 8×8 twill with a 6×6 twill will occupy 24 ends and 48 picks before it will commence to repeat. In other words, weaves when combined pick and pick will occupy a number of ends equal to the least common multiple of the number of ends on which each individual weave is complete, and a number of picks equal to twice the least common multiple of the number of picks in one repeat of each of the original weaves. In the above example the least common multiple of 8 and 6 is 24; therefore, the completed weave, as stated, will occupy 24 ends and $2 \times 24 = 48$ picks.

13. Derivative weaves are also formed by combining the ends of two weaves. The principles governing the combining of twills in their picks, also govern this case. Figs. 29 and 30 show two twills that it is desired to combine in this manner. Since they occupy a different number of ends, both the method of combining twills end and end and the method of determining the repeat of a weave formed by combining twills that occupy a different number of ends or picks will be

understood. Fig. 29 occupies 10 ends, while Fig. 30 occupies only 5 ends; consequently, Fig. 30 must be repeated twice in its ends in order to have it occupy the same number of ends as Fig. 29. It must also be repeated twice in its picks in order to have it occupy the same number of picks as Fig. 29. When Fig. 30 has been repeated in both ends and picks it will occupy 10 ends and 10 picks; there will then be two weaves each occupying 10 ends and 10 picks that are to be combined end and end. Consequently, the resulting weave will occupy 20 ends and 10 picks. If these two weaves were combined pick and pick, the resulting weave would occupy 10 ends and 20 picks.

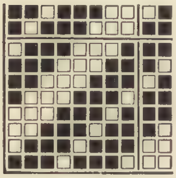


FIG. 29

FIG. 30

Fig. 31 shows the weave obtained by combining Figs. 29 and 30 end and end, commencing with the first end of Fig. 29 and the second end of Fig. 30. It will be seen that the first end of Fig. 31 is the first end of Fig. 29; the second end of Fig. 31 is the second end of Fig. 30; the third end of Fig. 31 is the second end of Fig. 29; the fourth end of Fig. 31 is the third end of Fig. 30; and so on until the weave repeats. It will be noticed that when all the ends of Fig. 30 have been used once they are used the second time in regular order to make the weave repeat.

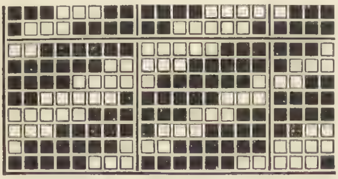


FIG. 31

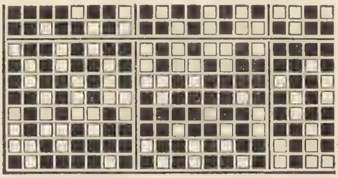


FIG. 32

Fig. 32 shows another weave formed by combining Figs. 29 and 30 end and end. In this case the first end of Fig. 29 is the first end of that weave taken, while the fifth end of Fig. 30 is the first end of that weave taken. Since the principles of producing different weaves when combining them pick and pick apply equally well to combining weaves end and end,

the number of different weaves that it is possible to produce by this method is as varied as the number that may be obtained by combining weaves in their picks. Moreover, the weaves that are combined may be rearranged in either their ends or picks after the manner described and then combined, etc., so that the number of weaves that may be obtained in this manner is almost without limit.

When twills are combined the angle is changed. Thus, if two regular 45° twills are combined end and end they form a 27° twill; if they are combined pick and pick they form a 63° twill. If three regular 45° twills are combined by taking a pick of each in regular order they form a 72° twill; if they are combined by taking an end of each in regular order they form an 18° twill.

EXAMPLES FOR PRACTICE

1. Show one repeat of the regular ${}^{4}_{4}{}^{3}_{3}$ twill on design paper.

2. From the weave formed in answer to question 1, form a weave by arranging the ends in the following order: taking the first end, skipping 2, taking the next, skipping 2, and so on until the new weave repeats.

3. Take the two weaves given in answer to questions 1 and 2 and combine them pick and pick, taking the first pick of the weave given for question 1, then the first pick of the weave given for question 2, and so on.

4. If a 10 × 10 twill is combined pick and pick with a 6 × 6 twill, on how many ends and picks will the new weave be complete?

5. If a 16 × 16 weave is combined end and end with an 8 × 8 weave, how many ends and picks will the new weave occupy?

FANCY TWILLS

14. In addition to the regular 45° twills there are many other twill weaves that may be considered as subdivisions of regular twills; these are very useful in many classes of fabrics. The first of these weaves that will be considered are those known as **fancy twills**. These weaves generally consist of a regular twill weave between the twill lines of which are placed sometimes other twills running in the

opposite direction, sometimes small spots, and sometimes other small weaves.

The first step in making such weaves is to construct a bold line of twill running across the design, as shown in Fig. 33. In order to change this regular twill into a fancy twill, it is

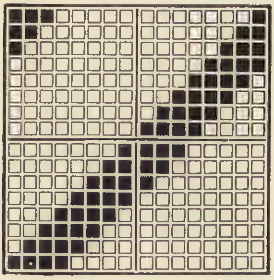


Fig. 33

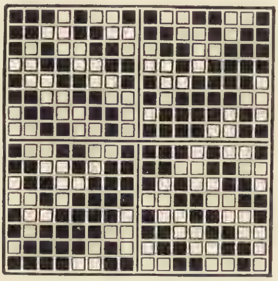


Fig. 34

necessary to insert some other weave on the blank squares. Fig. 34 shows this twill changed to a fancy twill; the method employed is that of running short lines of twill in a direction opposite to that of the main line of twill.

Figs. 35 and 36 show two other fancy twills. In Fig. 35, the fancy twill is formed by placing small spots between the

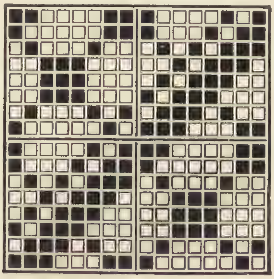


Fig. 35

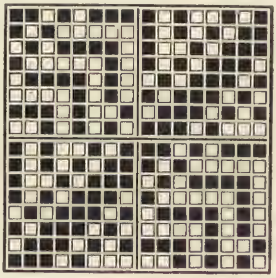


Fig. 36

main lines of twill; while in Fig. 36, the fancy twill is formed by placing a small weave, as shown, between the main lines of twill.

In making these weaves it should be noted that the entire weave runs up in a twill line and that it is essential to have

the first and last ends and also the first and last picks match; that is, the first end of the weave should be a continuation of the last end and the first pick should be a continuation of the last pick, so that the weave will continue perfectly when repeated in either direction. In order to accomplish this, it is necessary to have the spot or weave that is inserted occupy a number of picks that can be divided into the number of picks on which the entire weave is complete; otherwise, it will be necessary to continue the twill and spot weaves until a point is reached where they repeat together, which will occur on a number of picks equal to the least common multiple of the number of picks required by the twill and by the spot weave.

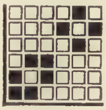


Fig. 37

In Fig. 34, the small twill weave may be said to occupy 4 picks, which is exactly divisible into 16, the number of picks that one repeat of the completed weave occupies. In Figs. 35 and 36, each inserted weave may be said to occupy 4 picks; this number is exactly divisible into 16, the number of picks that the complete weaves occupy.

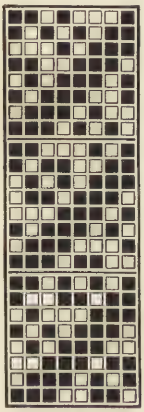


Fig. 38

When the weave that is inserted between the twill lines repeats on a different number of picks, the twill and inserted weave are both repeated in the picks until they repeat together, which occurs on a number of picks equal to the least common multiple of the number of picks on which the twill and spot weave are complete. For instance, suppose that it is desired to make a fancy twill weave by inserting Fig. 37 between the twill lines of a $\frac{3}{5}$ twill. Fig. 37 is complete on 6 picks, while the twill requires 8 picks; therefore, the completed fancy twill will require 24 picks, since 24 is the least common multiple of 6 and 8 and both will not commence to repeat together until the twenty-fifth pick. Fig. 38 shows the fancy twill thus obtained.

ENTWINING TWILLS

15. Entwining twills are constructed from regular twills by running sections of twill lines both to the right and to the left so that each section meets other sections at right angles. As their name indicates, the effects produced by these twills have an entwined or interlaced appearance; the more perfect ones are obtained when the separate sections are composed of equally flushed twills, although in some cases unequally flushed twills give good results. Fig. 39 shows an entwining twill constructed by running two twill lines of the cassimere to the right and two to the left, the weave repeating on 8 ends and 8 picks. Although two repeats in the ends and two in the picks are shown here, when constructing these twills, the number of ends and picks that one repeat of the weave will occupy must be ascertained at the start. This may be found by multiplying the number of ends and picks required for one repeat of the weave used by the number of twill lines in each section; thus, since in Fig. 39 two twill lines of the cassimere, or $\frac{2}{2}$, twill are used, the completed entwining twill occupies 8 ends and 8 picks $(2 \times 4 = 8)$. If it is desired to construct an entwining twill with the cassimere twill and have three twill lines in each section, 12 ends and 12 picks $(3 \times 4 = 12)$ will be required to show one repeat; if four twill lines in a section are wanted, 16 ends and 16 picks will be required, and so on. If the 6-end regular twill $\frac{3}{3}$ is used as a base instead of the cassimere and three twill lines are desired in each section, 18 ends and 18 picks $(3 \times 6 = 18)$ will be required for one repeat of the completed entwining twill. In constructing an entwining twill, therefore, it is first necessary to decide on the twill weave to be used as a base and also on the number of twill lines to be used in each section, from which the number of ends and picks required for one repeat can be found.

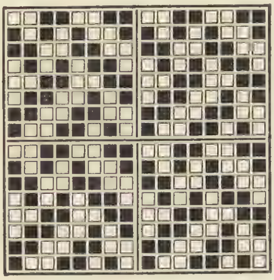


FIG. 39

To illustrate the method of constructing these weaves, suppose that it is desired to make an entwining twill with the cassimere twill $\frac{2}{2}$, having five twill lines in each section, which will give an entwining twill complete on 20 ends and 20 picks $(5 \times 4 = 20)$. The first step is to run up the first twill line of one section, as shown in Fig. 40 (*a*), continuing

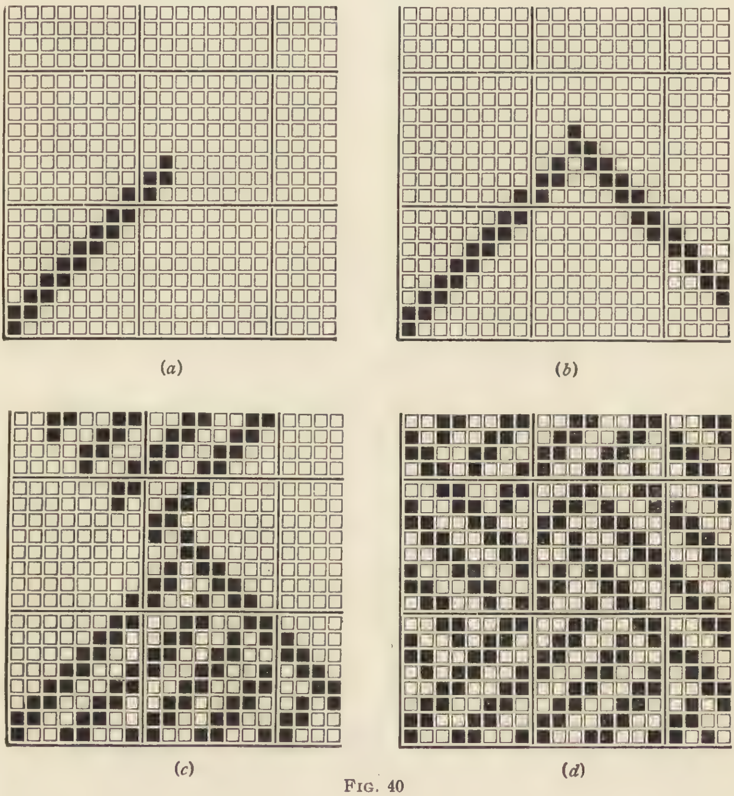
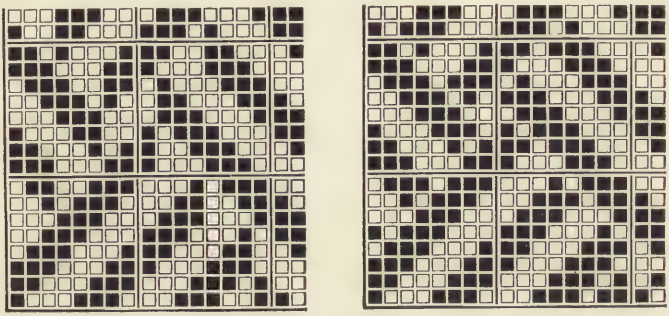


FIG. 40

it for a number of ends equal to one-half the total number of ends to be occupied by the repeat. Next insert the first twill line of the section of twill lines that run in the opposite direction, starting it on the next end to and just above the last riser of the first twill line and running it down in the opposite direction, as shown in Fig. 40 (*b*). Next return to the

first section, that is, the one running to the right, and complete it by running the four other twill lines parallel to the first twill line that has already been obtained. Each twill line must be continued, as shown in Fig. 40 (*c*), until it



(*a*) (*b*)

FIG. 41

occupies the same number of ends as the first twill line; namely, a number of ends equal to one-half of the number occupied by the completed weave, or in this case 10 ends. By completing the section of twill lines running to the left in the same manner, that is, by adding the other four twill lines parallel to the one already obtained, the completed weave is obtained, as shown in Fig. 40 (*d*).

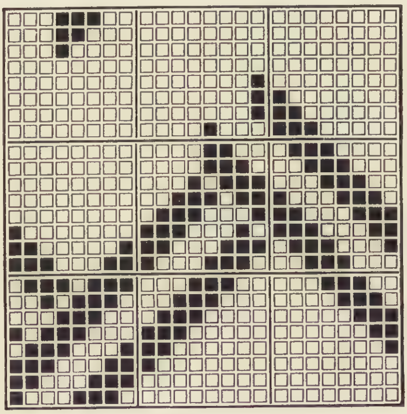


FIG. 42 (*a*)

When the warp floats over more than 2 picks in a twill used as the base of an entwining twill, it is usually advisable to add one or more extra risers to the ends of each warp twill line in order to make the twill lines meet each other better and also to shorten the warp floats on the back of the cloth at the junction of the right and left twill lines. For instance, Fig. 41 (*a*) shows an entwining

twill constructed with three lines of the $\frac{3}{3}$ regular twill in each section, and while this weave is perfectly constructed, if one extra riser is added to each end of every twill line, as shown in Fig. 41 (*b*), the weave will be enhanced in value. It is very often necessary to alter the ends of each twill line, either by adding or taking out risers in order to make each twill line meet others in the best possible manner; especially is this true in the case of entwining twills based on unequally flushed weaves. As the repeat of the weave is already determined, the addition of extra risers will not alter the number of ends and picks in the repeat nor the number of harnesses necessary to weave the design.

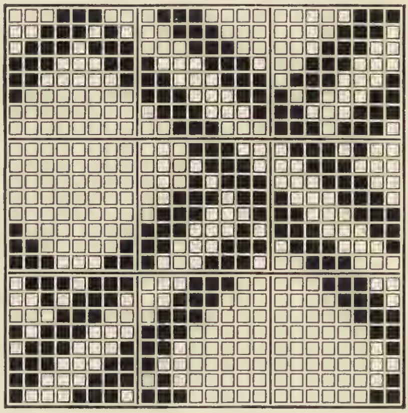


FIG. 42 (*b*)

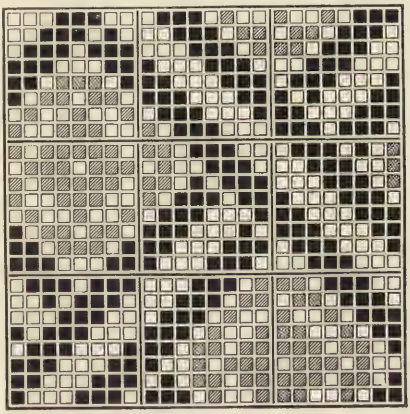


FIG. 42 (*c*)

Fancy entwining-twill effects are obtained by omitting one or more twill lines from each section and continuing the remaining twill lines of each section until they meet those of the other section. By this means two blank spaces are made in the weave, in which other weaves may be inserted. To illustrate the construction of these weaves, suppose that it is desired to make a fancy entwining-twill effect on 24 ends and 24 picks with the $\frac{3}{3}$ twill. In an ordinary entwining twill, this would

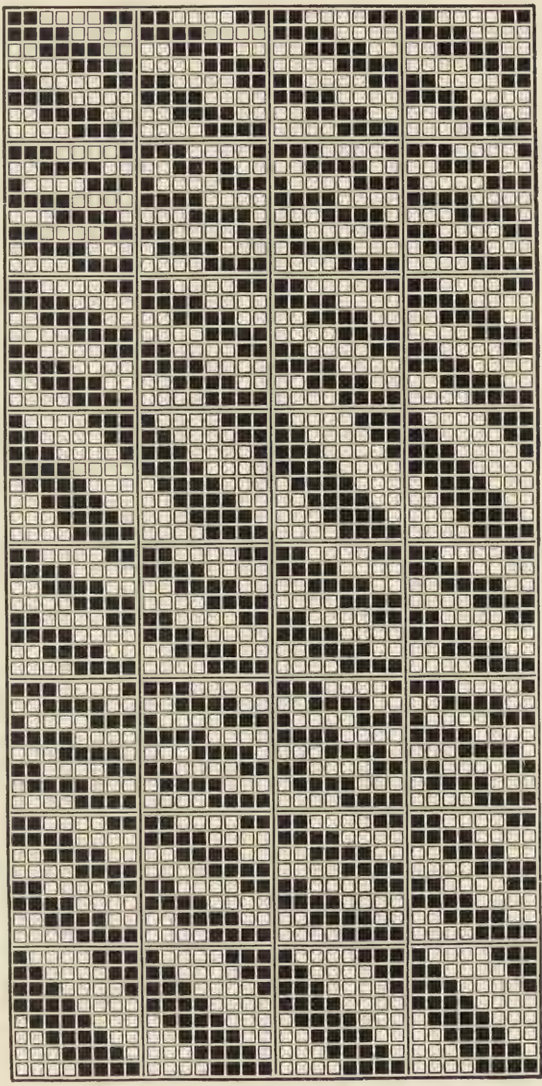
require four twill lines in each section, but since this is to be a fancy effect two of the twill lines in each section will be omitted. Fig. 42 (*a*) shows the weave constructed up to this point, but since two twill lines have been omitted from each section it is necessary to continue the two remaining twill lines across the space that would have been occupied by the other twill lines until they meet those of the other section, as shown in Fig. 42 (*b*). This leaves two blank spaces, as shown, in which any desired weave may be inserted, thus producing a fancy entwining twill, as shown in Fig. 42 (*c*), where the inserted weave is indicated by the shaded risers.

CURVED TWILLS

16. Curved twills are those in which the twill lines have a wavy, or curved, nature instead of being perfectly straight as in an ordinary twill weave. There are two methods of constructing these weaves, although the results are very similar in either case.

The first method consists of amalgamating several sections of twill weaves running at different angles, while by the second method the curved effect is obtained with a regular twill weave for a chain draft and a drawing-in draft so arranged as to produce the desired effect. Fig. 43 shows several repeats of a curved twill constructed in accordance with the first method. This weave repeats on 32 ends and 8 picks and is composed of four sections of 8 ends each; the first section is the regular 8-end 45° twill $\frac{4}{4}$; the second section is a twill having an angle of 63°; the third section is a twill with an angle of 72°; and the fourth section is like the second. It will be noticed that each end of the weave interlaces in the same manner as some one of the first 8 ends; therefore, the weave may be woven with 8 harnesses and the first 8 ends as a chain draft if the proper drawing-in draft is used; this shows that the second method of constructing curved twills is really based on the first.

Fig. 44 (*a*) shows several repeats of a curved twill constructed by the second method with the chain draft shown in



4th section

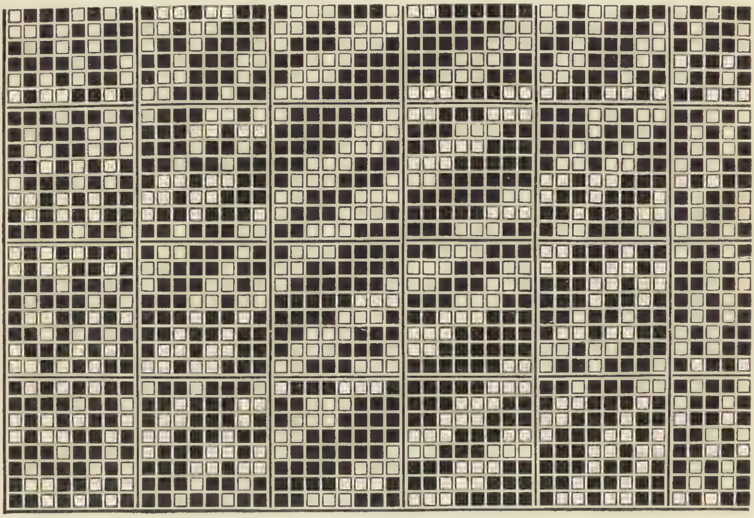
3d section

2d section

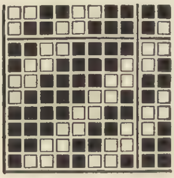
1st section

FIG. 43

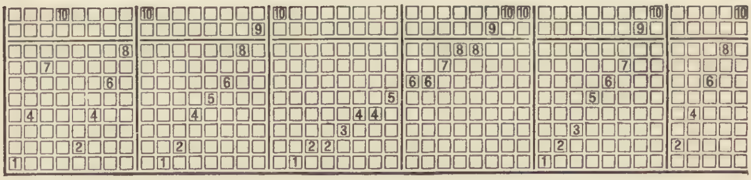
Fig. 44 (*b*) and the drawing-in draft Fig. 44 (*c*). The first end of the effect in Fig. 44 (*a*) is like the first end of Fig. 44 (*b*); the second end is like the fourth end; the third,



(*a*)



(*b*)



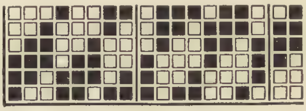
(*c*)

FIG. 44

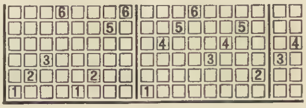
like the seventh; the fourth, like the tenth; and so on, each end of Fig. 44 (*b*) being taken in the order indicated by the drawing-in draft in Fig. 44 (*c*).

SKIP TWILLS

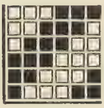
17. Skip twills are a type of broken twill effects formed by a skip drawing-in draft and a regular twill weave as a chain draft. The drawing-in draft is made so that the ends are drawn in straight for a certain number of harnesses; a number of harnesses are then missed; and afterwards the ends are again drawn in straight. The draft is so constructed that when the harnesses are skipped, the end in the harness just before the skip will rise and fall exactly opposite to the next end; by this means a broken effect is formed in the cloth. In Fig. 45 (*a*) is shown a skip twill that is made with the 6-end regular twill $\frac{3}{3}$, Fig. 45 (*c*), as a chain draft and the skip drawing-in draft shown in Fig. 45 (*b*). In this draft the first 3 ends are drawn straight; then 2 harnesses are skipped; 3 more ends are then drawn straight, and so on until a repeat is found.



(*a*)



(*b*)



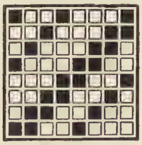
(*c*)

FIG. 45

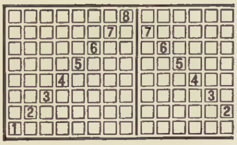
In this weave the fourth end rises and falls exactly opposite to the third end. This is accomplished by means of drawing the fourth end through the sixth harness instead of the fourth, as would be done with a straight draft. The seventh end rises and falls exactly opposite to the sixth, the tenth end opposes the ninth in the same manner, and so on until the eighteenth end is reached, which rises and falls exactly opposite to the first end. One end rising and falling in opposition to another in this manner is termed *cutting*. Skip twills are best constructed from equally flushed twills.

POINTED TWILLS

18. Another class of twill weaves obtained by means of the harness draft includes those weaves obtained by point drafts, which form wave effects across the cloth known as **pointed twills.** These effects are also frequently spoken of as *herring bones*, or *herring-bone stripes*, because the radiating twill lines suggest the radiating bones of a fish's backbone. Suppose that it is desired to make a pointed, or wave, effect with the 45° twill shown in Fig. 46 (*a*) as the chain draft; Fig. 46 (*b*) shows the harness draft that will be used, while Fig. 46 (*c*) shows the effect obtained in the cloth.



(*a*)



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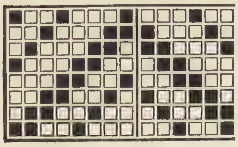
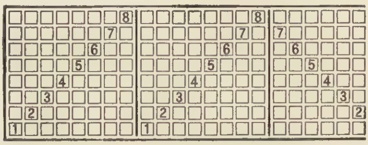


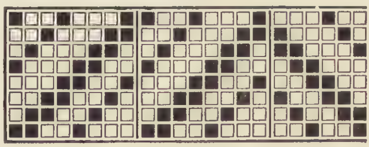
(*c*)

Fig. 46

One important point in connection with point drafts is that they always end on the second harness and not on the first, that is, assuming that the draft begins on the first harness. For instance, in Fig. 46 (*b*), the ends are drawn straight for the first 8 harnesses, when they are reversed, commencing with the seventh harness; when the harness draft reaches the second harness after being reversed, one repeat of the draft is obtained. If the last end of the draft were drawn through the first harness, the first and last ends of each repeat would work exactly alike, which would give in the cloth 2 ends side by side working alike. This would cause a serious defect in the fabric. If the weave shown in Fig. 46 (*c*) is repeated two or



(*a*)

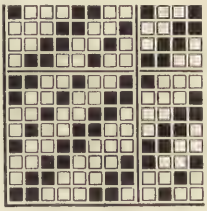


(*b*)

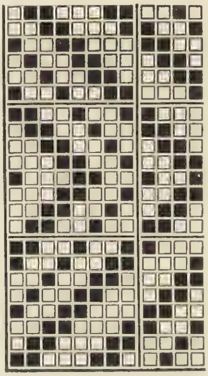
Fig. 47

three times in both ends and picks, a better idea of the waves formed by these weaves will be obtained.

Many good effects can be obtained by this method by changing the harness draft and using the same chain draft. Thus, instead of using a regular point draft like that shown in Fig. 46 (*b*), a draft like that shown in Fig. 47 (*a*) may be used; the effect, or weave, in this case, will be similar to that shown in Fig. 47 (*b*).



(*a*)



(*b*)

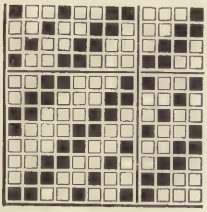
Fig. 48

19. The point twills thus far described will make waves across, or widthwise of, the cloth. The same effects, however, may be made to extend lengthwise of the cloth by simply reversing the chain draft in the same manner that the harness draft was reversed when making waves across the cloth.

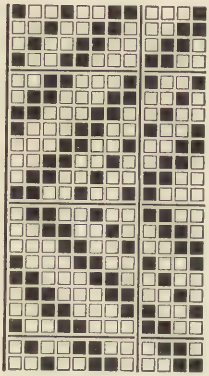
Suppose that it is desired to make a chain draft that will give a wave running lengthwise of the cloth from the twill shown in Fig. 48 (*a*). It is simply necessary to make a chain draft that will have the first 12 picks similar to Fig. 48 (*a*) and the remaining picks made by reversing these first 12 picks; that is, the thirteenth pick will be like the eleventh; the fourteenth, like the tenth; the fifteenth, like the ninth; the sixteenth, like the eighth; the seventeenth, like the seventh; the eighteenth, like the sixth; the nineteenth, like the fifth; the twentieth, like the fourth; the twenty-first, like the third; and the twenty-second, like the second. Here the chain draft will stop, in order to avoid having the first and last picks alike, on the same principle that the harness drafts of weaves making waves across the cloth stop on the second harness. Fig. 48 (*b*) shows the chain draft to give the wave lengthwise of the cloth; the harness draft will be a 12-harness straight draft.

DIAMOND WEAVES

20. By reversing both the harness and chain drafts of any regular twill, another class of weaves that is very largely used, and known as **diamond weaves** from the effects formed in the cloth, will result.



(*a*)



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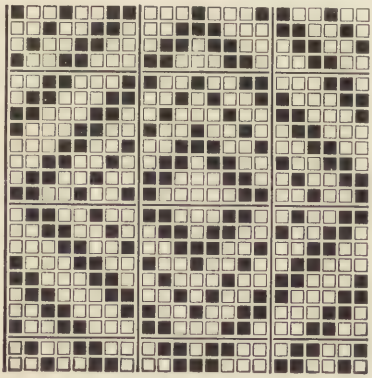


(*c*)

FIG. 49

Fig. 49 (*a*) shows a regular twill from which it is desired to construct a diamond weave. First build the chain draft by reversing the picks exactly as when forming waves lengthwise of the cloth. For the purpose of illustration, however, the picks will be reversed from the first pick, instead of from the last as in the previous illustration. It should be understood that in either case the weave will be the same. Fig. 49 (*b*) shows Fig. 49 (*a*) reversed in this manner. Fig. 49 (*b*) should be considered as the chain draft of the desired weave, while the drawing-in draft will be a regular point draft made on the same principle as the drawing-in drafts for the regular weaves that were made into waves extending across the cloth. The chain draft occupies 12 harnesses and consequently the drawing-in draft will be the 12-harness regular point draft. In other words, the ends will be drawn in the following order: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2. It should be noticed that in this case, as well as in weaves forming wave effects, the last

pick joins perfectly with the first; also the last end with the first. In order to show the effect that will be formed in the cloth when using Fig. 49 (*b*) for the chain draft and drawing in the warp ends as described, the weave has been worked out and is shown in Fig. 49 (*c*).

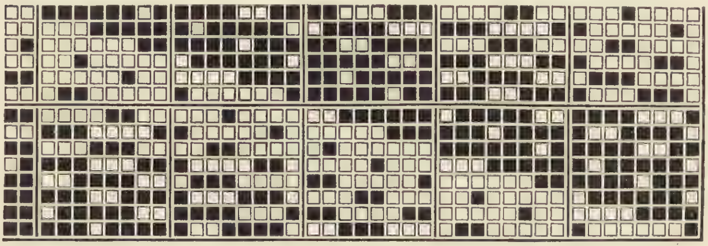
DIAGONAL WEAVES

21. Shaded Diagonals.—Diagonal weaves may be considered as a type of twill weaves, the term being generally confined to bold twills running at angles greater than 45°, although often regular 45° twills are spoken of as diagonals; regular diagonals are generally formed by combining two regular 45° twills in their picks or ends. As the formation of other weaves by combining twills pick and pick or end and end has been fully explained, it will not be necessary to give further details of these weaves, but simply to state that all the examples under this method of forming weaves may be considered as diagonals.

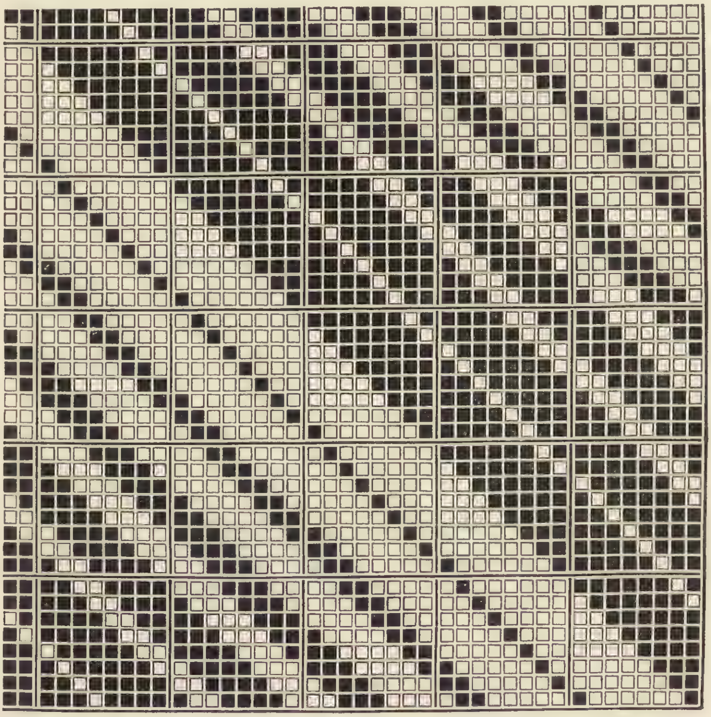
There is, however, a subdivision known as **shaded diagonals**, which are formed on a twill basis by taking as the base of the twill a different number of risers and sinkers in the different sections, grading from light to dark or from dark to light. For instance, suppose that a shaded diagonal is to be made from a regular 45° twill that is complete on 42 ends and 42 picks. Divide the first pick of the weave into six sections of 7 ends each. Then beginning with the first section leave only 1 end down; that is, this part would be marked $\frac{6}{1}$. In the next section leave 2 ends down, making this section $\frac{5}{2}$. Continuing in this manner, the next section will be $\frac{4}{3}$; the next section, $\frac{3}{4}$; the next section, $\frac{2}{5}$; while the last section will be marked $\frac{1}{6}$; therefore, the first pick of this weave would be marked $\frac{6}{1}\frac{5}{2}\frac{4}{3}\frac{3}{4}\frac{2}{5}\frac{1}{6}$. It is next necessary to run up this twill in the regular 45° manner until it is complete; that is, until it occupies 42 ends and 42 picks. Fig. 50 (*a*) shows the complete weave.

After the regular twill has been formed it is necessary to decide what angle the diagonal shall form. If it is to be

a 63° diagonal, every other end of the regular twill may be taken. If it is to form an angle of 72°, every third end of the regular twill will be taken, and so on. Suppose that in



(b)

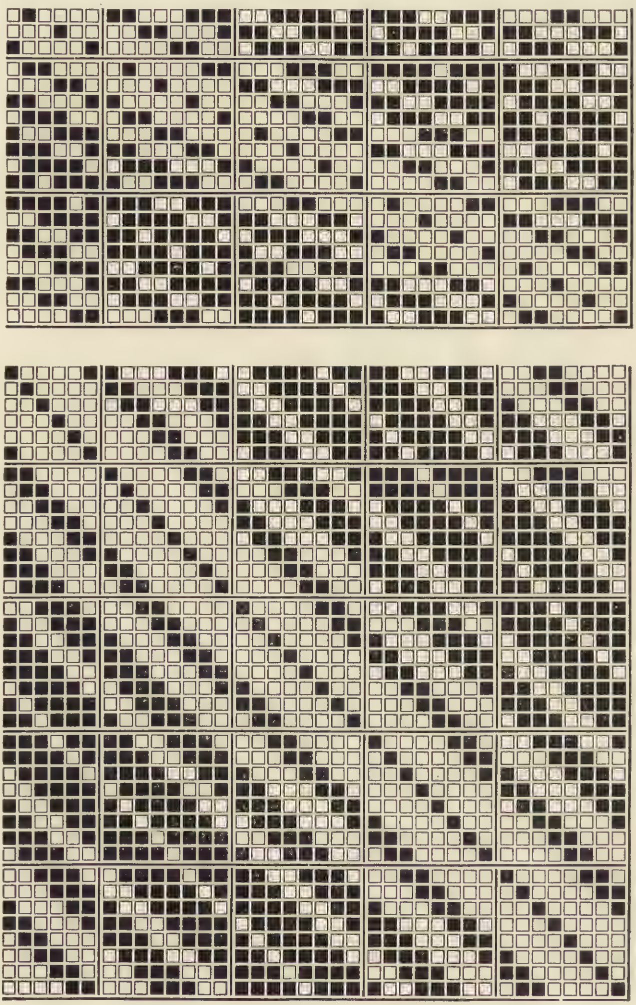


(a)

Fig. 50

this case it is desired to have the diagonal form an angle of 72°. Then every third end of the regular twill shown in Fig. 50 (a) will be taken. As 3 can divide evenly into 42,

the number of ends on which Fig. 50 (*a*) is complete, the diagonal is complete on 42 ÷ 3, or 14, ends. Commencing then with the first end in Fig. 50 (*a*) and taking every third



(*b*)

(*a*)

Fig. 51

end of the weave, Fig. 50 (*b*) will result. Thus, the first end of Fig. 50 (*b*) is the first end of Fig. 50 (*a*); the second end of Fig. 50 (*b*) is the fourth end of Fig. 50 (*a*); the third

end of Fig. 50 (*b*) is the seventh end of Fig. 50 (*a*); and so on until every third end of the regular twill has been taken. Fig. 50 (*b*) will form a shaded effect in the cloth; that is, commencing with a certain part of the weave a large part of the warp will be found to float on the surface. The weave is then shaded gradually until a point is reached where the filling will be found to predominate largely on the surface.

In many cases these diagonals are made to shade in both directions; that is, the warp floats will be found gradually to grow less until the filling predominates, when the weave will again be shaded until the warp predominates, instead of breaking off suddenly as in Fig. 50 (*b*).

In making the regular twill weave for the base of a shaded diagonal, the most perfect results are obtained if the weave is equally flushed. In order to find this base, the following method is employed: Mark the numbers that indicate the number of warp ends to be lifted over the first pick, beginning with 1 and running up as high as desired, repeating the highest number and then grading down again but stopping with 2 instead of 1; thus, $\underline{1\ \ 2\ \ 3\ \ 4\ \ 4\ \ 3\ \ 2}$. Then put 1 to represent one end down between the two highest numbers and grade in each direction until the highest number is reached at each end; thus, $\frac{1\ \ 2\ \ 3\ \ 4\ \ 4\ \ 3\ \ 2}{\ \ 4\ \ 3\ \ 2\ \ 1\ \ 2\ \ 3\ \ 4}$. This method makes a perfect, equally flushed weave, since the same number of warp ends are up as are down, and also where 4 warp ends are up in succession 1 end is down between them, and where 4 warp ends are down in succession 1 warp end is up between them. Fig. 51 (*a*) shows the regular twill weave formed in this manner with the base given, and Fig. 51 (*b*) shows a 63° diagonal derived by taking every other end in proper rotation.

Shaded diagonal weaves are woven with a warp of one solid color and a filling of another solid color opposed to that of the warp, as for instance, a black warp and white filling, or vice versa; this brings out the shaded effect of the weave.

EXAMPLES FOR PRACTICE

1. Make a regular twill weave from the base $\frac{1}{5}\frac{2}{4}\frac{3}{3}\frac{4}{2}\frac{5}{1}$.

2. From the weave given in answer to question 1 construct a 72° shaded diagonal.

3. Extend the base of the twill given in question 1 and from the twill formed by this new base construct a 63° shaded diagonal that will be shaded in both directions.

4. Make an original diamond weave.

SATIN AND OTHER WEAVES

SATINS

1. Satin, or sateen, weaves constitute one of the most valuable classes of fundamental weaves, and are used in almost every branch of weaving and with yarns of every material. They are used in woolen cloths to produce *doeskins*, in cotton cloths for the production of *sateens* and *satinettes*, and in silk goods for *satins*. One of the largest uses of satin weaves is in the production of linen damasks, in which warp-flush and filling-flush satins are combined to produce figured table cloths, napkins, etc. They are also largely used as ground weaves for spotted and figured cloths and are often combined to form check and stripe effects in various fabrics.

2. Comparison of Twills and Satins.—Satin weaves, in a certain sense, are the exact opposite of twills, since while it is the object of a twill weave to show a twill line running diagonally across the cloth, in the satin weave all twill lines are avoided as far as possible, although in some cases a slight twill effect is shown in a cloth woven with a satin weave, by means of the direction of the twist in the warp and filling yarns. Another of the principal features of a twill weave is the supporting of one end by another, but in a satin weave this is carefully avoided; that is, in a satin weave the interlacing of each end is at least 1 pick apart from the interlacing of either of the ends next to it. In a regular satin weave, each end interlaces with the filling only

once in one repeat of the weave. Fig. 1, which shows a 5-end warp-flush twill, and Fig. 2, which shows a 5-end warp-flush satin, illustrate these points. Although in the twill weave only one interlacing is made on each pick, the ends support each other, since on the first pick the first end is down and on each succeeding pick the next end is down, thus forming a twill line. With the satin weave, only 1 end is down on each pick, it being in this respect similar to the twill weave, but the interlacing of each end is at least 1 pick apart from the interlacing of either of the 2 ends next to it. Thus on the first pick, the first end is down; on the next pick, the fourth end is down; on the third pick, the second end is down; on the fourth pick, the fifth end is down; and on the fifth pick, the third end is down; consequently, the points of interlacing do not run up in regular order, as is the case in a regular twill weave, but are scattered over the weave. By this means the interlacings of the warp and filling are almost entirely hidden, while the cloth produced is smooth and soft, this being the object of the weave.

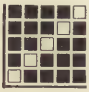


Fig. 1

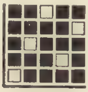


Fig. 2

3. Base for Satin Weaves.—The order in which the ends are raised or lowered when forming a satin weave is generally indicated by a series of figures, in which each figure represents an end, while its position in the series indicates the pick on which it is moved. Thus, referring to the 5-end satin in Fig. 2, the ends would be said to be lowered in 1, 4, 2, 5, 3 order: 1 being the first number, shows that the first end is lowered on the first pick; 4 being the second number, shows that the fourth end is lowered on the second pick; 2 being the third number, shows that the second end is lowered on the third pick; 5 being the fourth number, shows that the fifth end is lowered on the fourth pick; and 3 being the fifth number, shows that the third end is lowered on the fifth pick.

Considering the order of moving the ends, as shown in Fig. 2, on each successive pick, the third end (counting

from left to right) from the one previously lowered is down. Thus, on the first pick, the first end is down; on the second pick, the third end from that, or the fourth, is down; on the next pick, the third end from the fourth, or the second, is down; and so on for the 5 picks that complete one repeat of the weave. This is known as *moving in threes;* that is, 3 is taken as a base for constructing the weave. When determining the base on which to construct a satin weave, any number may be taken that is neither a factor of the whole number of ends in one repeat nor a multiple of any such factor, exclusive of the number 1 and the number that is 1 less than the number of ends on which the satin under consideration is complete. Thus, in the case of the 5-end satin, 3 is a number that cannot be equally divided into 5, the number of ends in the repeat; neither can any number that is equally divisible into 5 be equally divided into 3. The number 2 could also be taken as the base for a 5-end satin, in which case the ends would be moved in the following order: 1, 3, 5, 2, 4.

4. Warp- and Filling-Flush Satins.—Satin weaves may be either **warp-flush** or **filling-flush;** the former contains more warp yarn on the face, while the latter contains more filling on the face. Warp and filling satins, as shown on design paper, may be readily distinguished, for if there are more filled-in than blank squares, as in Fig. 2, the warp will predominate, since filled-in squares represent the warp ends lifted, and the weave will be a *warp satin.* In case there are more blank than filled-in squares, as in Fig. 3, the weave will be a *filling satin*, since the blanks represent filling over warp.

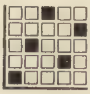


Fig. 3

When a satin is a warp satin, the ends are said to be *lowered* in a certain order, while with a filling satin the ends are said to be *raised* in a certain order. Thus, for example, in speaking of the weave in Fig. 2, the ends are said to be lowered in 1, 4, 2, 5, 3 order, while the ends of the filling satin shown in Fig. 3 are said to be lifted in 1, 4, 2, 5, 3 order.

Cloths with a satin weave are sometimes woven face down, in which case a warp satin has the ends *raised* according to the base of the satin, while a filling satin has the ends *lowered* according to the base. In this Course, however, cloth will always be considered as woven face up unless a definite statement to the contrary is made.

A filling satin generally contains more picks per inch than ends, so that the ends that are raised over the picks are nearly covered, thus causing the cloth to have a very soft feeling. A similar effect is produced in a warp satin, which generally contains more warp ends per inch than picks, thus causing the warp ends to crowd over the picks that are raised.

5. Six-End Satin.—The smallest number of ends on which a regular satin can be constructed is 5. It cannot be constructed on 6 ends, although in many cases a weave known as an *irregular satin* is made on 6 ends, the order of moving the harnesses being either 1, 3, 5, 2, 6, 4 or 1, 4, 2, 6, 3, 5. With weaves in which the ends are raised or lowered in either of these orders, no two adjacent ends are moved on successive picks; or in other words, no two ends support each other, and yet the same number of ends are not skipped between successive picks. Take, for example, the first order. If a warp satin is being considered, on the first pick the first end is lowered; on the second pick the second end from the one previously lowered, counting from left to right, or the third, is lowered; on the the third pick the second end from the previous one, or the fifth, is lowered; but on the next pick the third end from the fifth, or the second, is lowered; on the next pick the fourth end from the second, or the sixth, is lowered; while on the last the fourth end from the sixth, or the fourth, is lowered. Thus, in certain parts of the weave the base for counting off the ends is 2; in others it is 3; while in still others it is 4.

6. Construction of Satin Weaves.—To illustrate more fully the method of obtaining the base for any satin weave, it will be supposed that it is desired to make a regular satin on 7 ends. In any case where it is desired to construct

a satin weave on an odd number of ends, 2 can always be taken as the base, since 2 is neither a factor of any odd number nor a multiple of any factor of an odd number. Thus, in a 7-end satin the ends can be moved in 1, 3, 5, 7, 2, 4, 6 order, in which case the order of moving the ends is regular, and at the same time no two ends support each other; consequently, the satin will be regular. Another order of moving the ends in a 7-end satin is by threes, in which case the following results: 1, 4, 7, 3, 6, 2, 5; that is, on the first pick the first end is moved; on the second pick, the fourth end; on the third pick, the seventh end; on the fourth pick, the third end; on the fifth pick, the sixth end; on the sixth pick, the second end; and on the seventh pick, the fifth end. Still another base that may be taken for a 7-end satin is 5, in which case the ends are moved in the following order: 1, 6, 4, 2, 7, 5, 3. Another base is 4, in which case the ends are moved as follows: 1, 5, 2, 6, 3, 7, 4.

For another example, suppose that it is desired to construct a satin weave on 9 ends. It is first necessary to obtain a number smaller than 9 that is not equally divisible into the total number of ends and that cannot be divided equally by any number that can be divided into 9. The number 5 answers these conditions, and if taken as a base for moving the ends will give the following: 1, 6, 2, 7, 3, 8, 4, 9, 5. With this order, the first end is moved on the first pick; on the second pick, the sixth end is moved; on the third pick, the second; on the fourth pick, the seventh; and so on until all the ends are moved once, which gives one repeat of the weave.

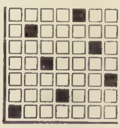


Fig. 4

Fig. 4 shows a 7-end filling satin constructed on a base of 3. On the first pick, the first end is raised; on the second pick, 2 ends are missed and the fourth end raised; on the next pick, 2 ends again are missed and the seventh end raised. This method of skipping is continued for 7 picks, which is one repeat of the weave. When the last end, or in this case the seventh, is reached, the next end to be counted is the first. Thus, for instance, on the third pick of this weave the seventh end

is raised. Counting from this end to see which end will be raised on the next, or fourth, pick, the first end is considered as 1, the second as 2, and the third end from the seventh will be the third end of the weave, which will be the end to be raised on this pick. This is due to the fact that as one repeat of the weave occupies only 7 ends, the eighth end of the weave is like the first, the ninth like the second, and so on.

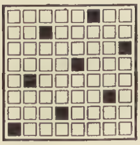


FIG. 5

Fig. 5 shows an 8-end filling satin constructed on a base of 3; that is, one end is raised on one pick and on the next pick the third end from the one previously raised is lifted.

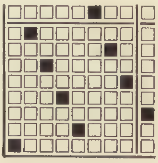


FIG. 6

Fig. 6 shows a 9-end filling satin weave constructed on a base of 4. Thus, on the first pick, the first end is raised; on the second pick, the fourth end from this one, or the fifth, is raised; on the third pick, the fourth end from the fifth, or the ninth, is raised; on the fourth pick, the fourth end from the ninth, or the fourth, is raised. This is continued for the 9 picks, which completes the repeat.

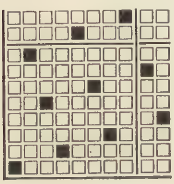


FIG. 7

Fig. 7 shows a 10-end filling satin with a base of 3.

Fig. 8 shows a 9-end warp satin weave constructed on a base of 4. In warp satins all the ends in one repeat of the weave are up on each pick with the exception of one pick. Thus, in the case of Fig. 8, on the first pick all the ends are raised with the exception of the first end; on the second pick, the fourth end from this first end, or the fifth, is lowered; on the third pick, 3 ends are skipped and the ninth end is lowered; on the fourth pick, 3 ends are skipped and the fourth end is lowered. This is continued for the 9 picks that complete one repeat of the weave.

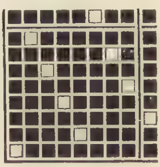


FIG. 8

Fig. 9 shows a 10-end warp satin weave constructed on a base of 3.

7. The lifting of the harnesses in a filling satin weave is given in the order that the ends are raised on each successive pick. Thus, for instance, in Fig. 5 the harnesses are raised in 1, 4, 7, 2, 5, 8, 3, 6 order. This indicates that on the first pick, the first harness is raised; on the second pick, the fourth harness is raised; on the third pick, the seventh harness is raised; on the fourth pick, the second harness is raised; on the fifth pick, the fifth harness is raised; on the sixth pick, the eighth harness is raised; on the seventh pick, the third harness is raised; on the eighth pick, the sixth harness is raised.

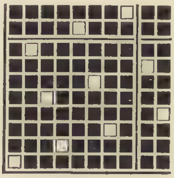


FIG. 9

5-END SATINS
1, 4, 2, 5, 3
1, 3, 5, 2, 4

6-END SATINS
1, 3, 5, 2, 6, 4
1, 4, 2, 6, 3, 5

7-END SATINS
1, 4, 7, 3, 6, 2, 5
1, 3, 5, 7, 2, 4, 6
1, 6, 4, 2, 7, 5, 3
1, 5, 2, 6, 3, 7, 4

8-END SATINS
1, 4, 7, 2, 5, 8, 3, 6
1, 6, 3, 8, 5, 2, 7, 4

9-END SATINS
1, 3, 5, 7, 9, 2, 4, 6, 8
1, 8, 6, 4, 2, 9, 7, 5, 3
1, 5, 9, 4, 8, 3, 7, 2, 6
1, 6, 2, 7, 3, 8, 4, 9, 5

10-END SATINS
1, 4, 7, 10, 3, 6, 9, 2, 5, 8
1, 8, 5, 2, 9, 6, 3, 10, 7, 4

11-END SATINS
1, 3, 5, 7, 9, 11, 2, 4, 6, 8, 10
1, 10, 8, 6, 4, 2, 11, 9, 7, 5, 3
1, 4, 7, 10, 2, 5, 8, 11, 3, 6, 9
1, 9, 6, 3, 11, 8, 5, 2, 10, 7, 4
1, 5, 9, 2, 6, 10, 3, 7, 11, 4, 8
1, 8, 4, 11, 7, 3, 10, 6, 2, 9, 5
1, 6, 11, 5, 10, 4, 9, 3, 8, 2, 7
1, 7, 2, 8, 3, 9, 4, 10, 5, 11, 6

12-END SATINS
1, 6, 11, 4, 9, 2, 7, 12, 5, 10, 3, 8
1, 8, 3, 10, 5, 12, 7, 2, 9, 4, 11, 6

Generally a chain draft for a satin weave is made like the weave; that is, in most cases the weave is also the chain draft, and when this is the case the ends are drawn in straight, or in other words, through the harnesses in consecutive order.

The preceding table gives the different orders of moving the ends in satin weaves complete on 12 ends or less.

8. Double Satins.—Weaves known as **double satins** are sometimes constructed from regular satins. These are made by adding one mark to each mark in a regular satin; that is, in case the satin is a filling satin, each end will be raised an extra time during one repeat of the weave, and in case the satin is a warp satin, each end will be lowered an extra time during one repeat of the weave. These marks may be placed above, below, or at the side of the regular satin marks. Double satin weaves are principally used when it is desired to increase the strength of the goods and yet retain the satin face.

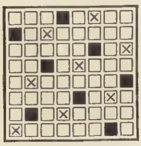


Fig. 10

Fig. 10 illustrates a double satin. The crosses represent a regular 8-end satin weave constructed on a base of 3, giving the following order of lifting the harnesses: 1, 4, 7, 2, 5, 8, 3, 6. In order to convert this regular satin weave into a double satin, one riser is placed on each pick in addition to the riser of the regular satin weave. Thus, on the first pick, in addition to the first end being raised the seventh end is also raised. In all double satin weaves the extra risers must be placed in regular order; that is, on the second pick the extra riser must be placed in the same relative position to the riser of the regular satin on that pick as was the extra riser on the first pick to the riser of the regular satin weave on that pick. Thus, on the first pick of the weave shown in Fig. 10, 5 ends are skipped after marking the riser for the regular satin, and the seventh end marked with an extra riser; on the second pick the fourth end is marked with a riser of the regular satin, 5 ends skipped, and the second end raised, which corresponds to the method of marking the extra riser on the first pick of the weave. This is continued throughout the 8 picks that complete one repeat of the weave.

Fig. 11 is another illustration of a double satin weave. In this case the extra risers are placed at the right of the risers

of the regular satin weave. Thus, on the first pick the first end is raised for the regular satin weave, and in order to make a double satin the square to the right of the one containing the riser of the regular satin weave is marked, or in other words the second end is raised with the first. The same method is followed with each pick of the weave.

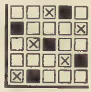


FIG. 11

Fig. 12 shows an 8-end double satin. The crosses show the order of lifting the ends for a regular satin weave, while the filled-in squares show the extra ends that are raised in order to make the satin double.

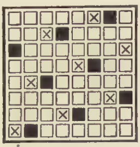


FIG. 12

Double satins are sometimes constructed by dividing the base that would be used for a regular satin into two numbers and using these numbers alternately for marking the risers of the double satin. Fig. 13, which is a 12-harness double satin constructed on this principle, illustrates these weaves. In this case the number 7, which could be used for the base of a regular satin on 12 ends, is divided into the two numbers 3 and 4 and these numbers used for constructing the weave. Considering first the squares that are marked with crosses, on the second pick, the fourth end from the end raised on the first pick is raised; on the third pick, the third end from the end raised on the second pick is raised; on the fourth pick, the fourth end from the end raised on the third pick is raised; on the fifth pick, the third end from the end raised on the fourth pick is raised. This is continued for the 12 picks, when it is necessary to return to the first pick; since on the twelfth pick the fourth end from the end raised on the eleventh pick is raised, on the first pick the third end from the end raised on the twelfth pick is raised. The filled-in squares show the risers that are obtained by continuing the process through the ends and picks the second time.

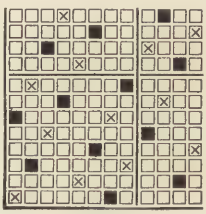


FIG. 13

Fig. 14 shows a weave made on somewhat the same principle as Fig. 13. In this case, however, the two risers are

marked on 1 pick before moving to the next pick. Thus, on the first pick the first end is raised and also the third end from the first. Moving to the second pick, the fourth end from the last end raised on the first pick is raised, which gives a riser on the eighth end for the second pick. In addition to this end being raised on the second pick, the third end from it is also raised, which gives a riser on the eleventh end. Moving to the third pick, as the eleventh end was the last end to be marked on the second pick, the third end, which is the fourth end from the eleventh, will be raised on the third pick. In addition to this end the third end from it, or the sixth, is also raised on the same pick. This method is continued throughout the 12 picks.

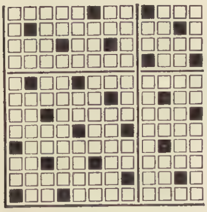


FIG. 14

EXAMPLES FOR PRACTICE

1. Make a warp satin on 16 harnesses, moving in fives.

2. Make a filling satin on 16 harnesses, moving in sevens.

3. From the weave formed in answer to question 2 construct a double satin by adding one riser on each pick of the satin weave.

4. (*a*) What is the smallest number of harnesses on which a regular satin weave can be constructed? (*b*) Show a satin weave on this number of harnesses.

DERIVATIVE WEAVES

9. Satin Derivatives.—Satin weaves provide a ready means for constructing other weaves, or **derivatives,** as they are called. In almost every case satin derivatives are formed by adding one or more extra risers to the risers of a regular satin. Fig. 15 shows one that might be considered

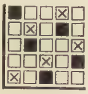


Fig. 15

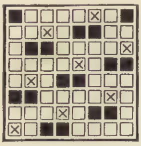


Fig. 16

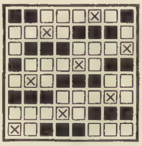


Fig. 17

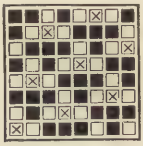


Fig. 18

a double satin, and yet would form a fine, upright twill in the weave. In the figures illustrating satin derivatives, the crosses show the method of raising the ends for the regular satin, while the filled-in squares show the risers that are added in order to form the derivatives. Fig. 16 is a satin derivative formed by adding two filled-in squares to each riser in a regular 8-end filling satin weave. Fig. 17 is one formed

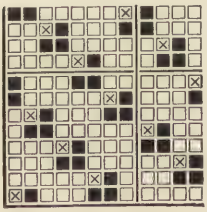


Fig. 19

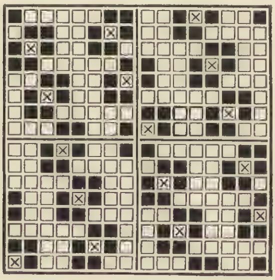


Fig. 20

by adding three risers to each riser in a regular 8-end satin. Fig. 18 is one formed by adding four risers to each riser of a regular 8-end satin weave. In all these cases, whenever it is necessary to extend the risers beyond the last end of the

weave they are carried to the first end, and in case it is necessary to extend the risers beyond the bottom pick of the weave they are carried to the top pick, or vice versa. Fig. 19 shows a derivative weave formed by adding three risers to each riser of a regular 12-end filling satin. Fig. 20 shows a satin derivative formed by adding six risers to each riser of a regular 16-end filling satin.

GRANITE WEAVES

10. In a **granite weave,** the intersections of the warp and filling are disposed throughout the weave in an irregular manner so that the floats of warp and filling will produce an indistinct yet regular pattern consisting of small broken effects. Granite weaves are largely used in almost every class of fabric, the cloths often being piece-dyed, but sometimes having the warp of one color and the filling of a contrasting color, thus giving the cloth a speckled appearance. They are made largely from regular satins by adding one or more risers to the risers of the satin weave; Figs. 16, 17, and 18 are good examples of granite weaves constructed in this manner. These weaves may also be obtained by rearranging a regular twill in so-called satin order; that is, taking the ends of the twill in the order followed when making a satin weave. For example, if the ends of an 8-end regular twill are rearranged in satin order on a base of 3, the ends are taken as follows: 1, 4, 7, 2, 5, 8, 3, 6; that is, the first end of the new weave will be like the first end of the twill; the second end will be like the fourth end of the twill; the third end will be like the seventh; the fourth end, like the second; the fifth end, like the fifth; the sixth end, like the eighth; the seventh end, like the third; and the eighth end, like the sixth. In other cases, granite weaves are constructed from regular twills by taking a certain number

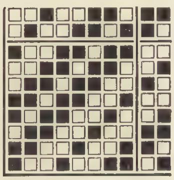


FIG. 21

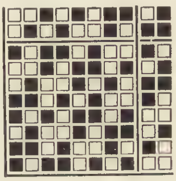


FIG. 22

of ends of the twill and then skipping a certain number, this being continued until the weave repeats. In the granite weave shown in Fig. 22, the ends of the regular twill shown in Fig. 21 have been rearranged by taking 2, skipping 4, and so on until the weave repeats.

BASKET WEAVES

11. Regular Basket Weaves.—Basket weaves are used frequently in all classes of woven fabrics; their chief feature is the regular occurrence of large floats of both warp and filling. The first type of basket weaves consists of those in which the squares of warp and filling are of equal size. These baskets are simply extensions of the plain weave both warp way and filling way, and it is always possible to weave them on 2 harnesses. Fig. 23 is a basket weave of this type, in which each square marked in a regular plain weave has simply been extended for 2 ends and 2 picks, thus making each mark occupy four squares instead of one. Fig. 24 shows another basket weave of this type, in which each mark of the plain weave has been extended for 3 ends and 3 picks; thus, instead of occupying only one square, each mark occupies nine. In Fig. 25, each mark is extended for 4 ends and 4 picks, and consequently occupies sixteen squares instead of one.

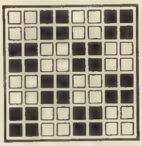


FIG. 23

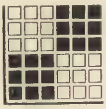


FIG. 24

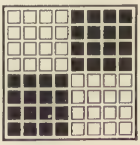


FIG. 25

12. Twill Baskets.—A second type of basket weaves consists of **twill baskets,** which are generally constructed on a satin base and produce much neater effects than the basket weaves just described. In making these weaves from a satin base, first mark out a satin weave on the desired number of ends and picks; then fill in squares around each of those marked off for the satin base, in such a manner that these groups of filled-in squares will form squares that run up in twill order. Fig. 26 shows a twill basket weave

constructed in this manner from an 8-end satin weave with a base of 5. The crosses show the satin weave, while the filled-in squares show the risers that are added in order to obtain the basket weave. In making these weaves, care should always be taken to have the filled-in squares around each mark of the satin base correspond in every particular;

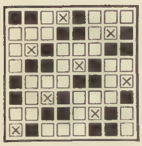


FIG. 26

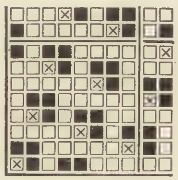


FIG. 27

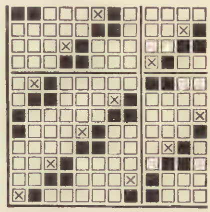


FIG. 28

that is, if on the first mark of the satin weave one square to the right and two below are filled in, as in Fig. 26, in the case of every other mark of the satin weave the corresponding squares must be filled in. Fig. 27 shows a twill basket weave constructed from a 10-end satin with a base of 7. Fig. 28 shows another one constructed from a 12-end satin with a base of 7.

13. Irregular Baskets.—A third type of basket weaves consists of **irregular baskets;** in these the squares of warp and filling are not exactly equal. Thus, in Fig. 29, the filled-in squares in one portion of the weave occupy 3 ends and 3 picks, while in another portion they occupy but 2 ends and 2 picks. In Fig. 30, the weave is formed by extending the warp floats in one case for 3 ends and 3 picks and in the other for 4 ends and 4 picks.

FIG. 29

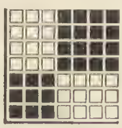


FIG. 30

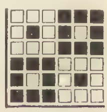


FIG. 31

14. Fancy Basket Weaves.—A fourth type of baskets consists of **fancy basket weaves.** In Fig. 31, the squares of filling are broken in the center by a float of warp, while the squares of warp are broken by a float of filling. Fig. 32

is another fancy basket weave constructed in the same manner. Fig. 33 shows a fancy basket weave constructed by separating warp floats of 4 ends and 4 picks each by 3 ends and 3 picks and filling in these intervening ends and picks with a suitable

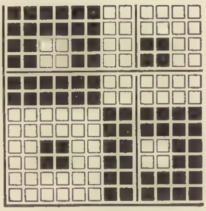


FIG. 32

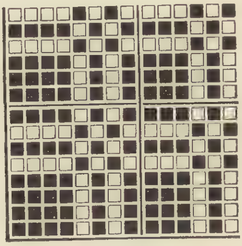


FIG. 33

weave. Two repeats of this weave in both ends and picks are shown in this figure. Fig. 34 is another weave made in somewhat the same manner. In this case, a plain basket weave consisting of warp and filling floats of 4 ends and 4 picks has the floats separated by 2 ends and 2 picks, which are filled in with a suitable weave. Two repeats of the weave in both ends and picks are given.

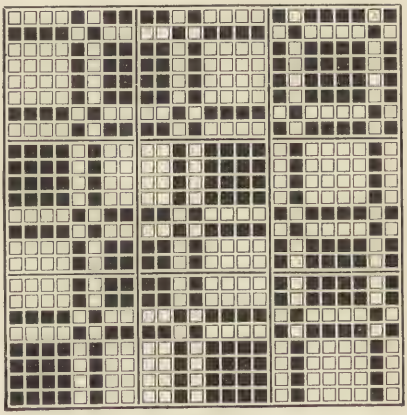


FIG. 34

RIB WEAVES

15. Warp Ribs. **Rib, or cord, weaves** are simply extensions of the plain weave in either the ends or picks alone and are of two classes—*warp ribs* and *filling ribs*. A **warp-rib weave** is an extension of a plain weave in its picks. In order to illustrate the construction of these weaves, Fig. 35, which shows a warp-rib weave, has been divided into two sections (*a*) and (*b*). In (*a*), all the odd numbered ends float over the filling for

4 picks, while the even-numbered ends are down. In (*b*), the reverse is the case; that is, the even-numbered ends float over the filling, while the odd-numbered ends are under the filling. With this class of weaves, a distinct line is formed across the cloth by means of the ends covering the filling.

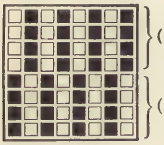


FIG. 35

Thus in Fig. 35 (*a*), for the 4 picks in which the odd-numbered ends are over the filling the ends will have a tendency to crowd together, especially if there are more ends than picks per inch in the weave, as there should always be in a warp-rib weave; that is, the first and third ends will cover the 4 picks of filling that are raised over the second end; the third and fifth ends for these 4 picks will cover the filling that is raised over the fourth end; the fifth and seventh ends will cover the filling that is raised over the sixth end; and the seventh and first ends will cover the filling that is raised over the eighth end. For the next 4 picks the reverse will be the case; that is, in (*b*) the second and fourth ends will cover the filling that is raised over the third end; the fourth and sixth ends will cover the filling that is raised over the fifth end, and so on. Consequently, in these 8 picks two distinct lines will be formed across the cloth because of different ends covering the filling in these two sections. This weave repeats on 2 ends and 8 picks, but four repeats of the weave in the ends are shown here in order that the construction of the weave may be understood more clearly.

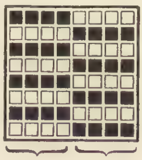


FIG. 36

16. Filling-rib weaves are the exact opposites of warp-rib weaves. As the filling covers the ends in these weaves, ribs are formed lengthwise of the cloth, and for this reason the cloth should always contain more picks per inch than ends. Fig. 36 is an illustration of a filling-rib weave. In (*a*), all the odd-numbered picks float over the 4 ends, while all the even-numbered picks are under the ends. In this case, the first and third picks will crowd over

the ends that are up on the second pick and completely cover them; the third and fifth picks will cover the ends that are raised on the fourth pick; the fifth and seventh picks will cover the ends that are raised on the sixth pick; and the seventh and first picks will cover the ends that are raised on the eighth pick, thus showing a distinct line of filling floats lengthwise of the cloth. In (*b*) the exact reverse is the case; that is, all the even-numbered picks are raised over the ends, while the ends are raised on the odd-numbered picks. By this means the second and fourth picks will cover the ends that are raised on the third pick; the fourth and sixth picks will cover the ends that are raised on the fifth pick, and so on, thus forming another rib of filling floats lengthwise of the cloth. This weave is complete on 2 picks and 8 ends, four repeats of the weave in its picks being shown here.

In warp-rib weaves the filling, and in filling-rib weaves the warp, is usually considerably coarser than the other series of yarn, in order to accentuate the ribbed effect in the cloth. In cloths woven with warp-rib weaves, there should be more ends than picks, and with filling-rib weaves, more picks than ends per inch.

17. Unequal Rib Weaves.—In Figs. 35 and 36, the ribs formed by the weaves are of equal size. This is not always the case, however, for **unequal rib weaves** are frequently used. Fig. 37 is an illustration of a weave of this kind. In the lower section, the odd-numbered ends float for 5 picks, while in the upper section the even-numbered ends float for only 3 picks. In this case there are two ribs of unequal size across, one rib being the width of 5 picks, while the other is the width of 3 picks.

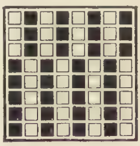
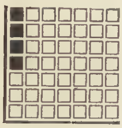


Fig. 37

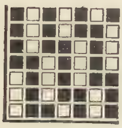
Unequal filling-rib weaves are formed in the same manner; that is, by having the filling float over an unequal number of ends.

CORKSCREW WEAVES

18. Corkscrew weaves may be considered a class of rib weaves; but while in rib weaves the ribs extend in a straight line either across the cloth or lengthwise of it, in corkscrew weaves the ribs from a twill line, and for this reason are sometimes known as *corkscrew twills.* Although these weaves may be formed on any number of ends or picks above 5, the best effects are obtained with weaves complete on an uneven number of ends and picks. One method of making a corkscrew weave that will be found as simple as any is as follows: Suppose that it is desired to form a corkscrew weave that will be complete on 7 ends and 7 picks. Divide 7 into two numbers one of which will be larger than the other by 1—in this case 3 and 4—then take 3 down and 4 up as the basis on which to mark each end in the corkscrew weave. The first end, as shown in Fig. 38 (*a*), will be lowered for 3 picks and raised for 4 picks. For the second end of the weave, begin on the first pick on which the first end is raised and mark the second end 4 up and 3 down, counting down. For the third end of the weave, commence on the first pick on which the second end is raised and mark 4 up and 3 down, counting down. Continue in this manner until the weave is complete. Corkscrew weaves that are complete on an odd number of picks will always be complete on the same number of ends as picks. Thus, in the case under consideration, since the weave is complete on 7 picks it will also be complete on 7 ends. The complete weave is shown in Fig. 38 (*b*). This weave is termed a *warp corkscrew,* since the warp ends cover the filling and, consequently, nothing but warp shows either on the face or the back of the cloth. In order that these weaves may appear to best advantage, it is necessary, as in the case of warp-rib weaves, to have more ends than picks per inch. Any warp corkscrew weave when turned quarter way around will give a filling corkscrew weave.



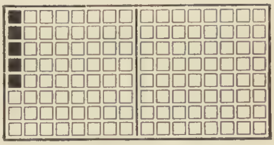
(*a*)



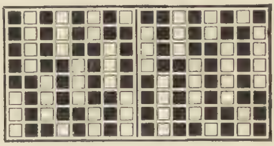
(*b*)

FIG. 38

Warp corkscrews made on an even number of ends and picks will not repeat until carried out for twice as many ends as picks. In constructing these weaves the number that represents the number of picks on which the weave is complete must be divided into two numbers, one of which will be larger than the other by 2. Suppose, for an example, that it is desired to construct a corkscrew weave that will be complete on 8 picks. The two numbers into which 8 is divided are 5 and 3. Mark the first end of the weave 3 down and 5 up, as shown in Fig. 39 (*a*). For the second end of the weave, commence on the first pick on which the first end is raised and raise the second end on this pick and also on all the picks on which the first end is lowered. The second end will therefore be up 4 picks and down 4 picks, whereas the first end is down 3 picks and up 5 picks. Marking the third end in the same manner as the second, this end will be up for 1 pick, down 3, and up 4 picks; it will thus be similar to the first end with regard to the length of the floats. The complete weave is shown in Fig. 39 (*b*).



(*a*)



(*b*)

FIG. 39

Since the ribs of this weave are formed by the ends that are raised crowding over the filling, two ribs will be formed diagonally across the cloth, one of which will be the width of 5 picks, while the other will be the width of only 4 picks.

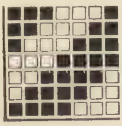


FIG. 40

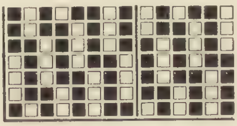


FIG. 41

19. Corkscrew weaves are often formed from twills: (1) by rearranging the ends or picks of a regular 45° twill; (2) by combining two twills end and end or pick and pick. Considering first the formation of corkscrew weaves by rearranging the ends of a regular 45° twill, suppose that it is desired to rearrange the ends of Fig. 40 in satin

order on a base of 4 to form a corkscrew weave. This will result in the corkscrew shown in Fig. 41, which gives two repeats of the weave in its ends. By rearranging the ends of a weave in this manner *warp corkscrews* are formed, while by rearranging the picks *filling corkscrews* are formed. Corkscrew weaves cannot readily be formed by rearranging the ends of every 45° twill; weaves similar to that shown in Fig. 40 are most suitable for this purpose.

When combining twills end and end or pick and pick to form a corkscrew weave, care should be taken to select such weaves as will give the desired effect. Figs. 42 and 43

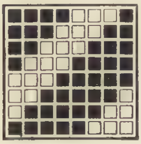


FIG. 42

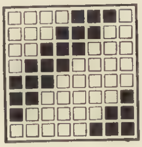


FIG. 43

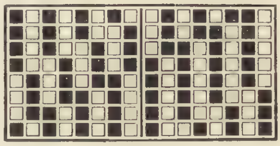


FIG. 44

show two 8-end twills that it is desired to combine end and end to form a corkscrew weave. Fig. 44 shows a weave formed in this manner; the first end of Fig. 44 is the first end of Fig. 42; the second end of Fig. 44 is the first end of Fig. 43; the third end of Fig. 44 is the second end of Fig. 42; the fourth end of Fig. 44 is the second end of Fig. 43, and so on for the 16 ends. By combining these two twills, the ends of which have different lengths of floats, there is formed a corkscrew twill that will have ribs of unequal size running diagonally across the cloth, since all the odd-numbered ends are up 5 picks and down 3 picks, while the even-numbered ends are up 3 picks and down 5 picks.

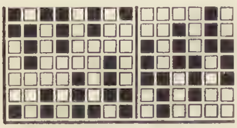


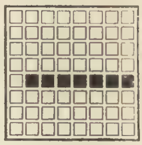
FIG. 45

20. Another class of corkscrew weaves includes those known as *warp corkscrews with filling effects.* These weaves may be formed by taking the ends of any filling-flush twill in such a manner as to form ribs in a twill line

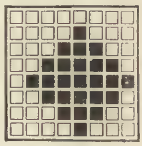
across the cloth and at the same time show a distinct line of filling floats. Fig. 45 is such a weave, constructed by taking the ends of the regular 45° 7-end twill $\frac{3}{4}$ in 1, 6, 2, 7, 3, 1, 4, 2, 5, 3, 6, 4, 7, 5 order.

HONEYCOMBS

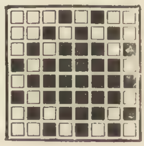
21. Honeycomb weaves are very common and are extensively used in making towels. When coarse, soft-twisted yarns are employed they make a spongy cloth well suited to this purpose. It is possible to make honeycomb weaves on any number of ends from 4 upwards, but the best effects are obtained with an even number of ends. When making these weaves the first thing to be decided on is the number of ends to be used. Suppose that it is desired to make a honeycomb weave on 8 ends and 8 picks. Raise all the ends, except the first, on any one pick of the weave, preferably one near the center of the design, as shown in Fig. 46 (*a*), in which the fourth pick has been selected and all the ends raised except the first. Next form a warp spot by marking the risers in regular 45° order from the first and last ends, as shown in Fig. 46 (*b*). After the spot has been formed, run a line of risers around it, leaving one blank space between these risers and those forming the spot, and confining this line of risers to 8 ends and 8 picks. On the pick shown in (*a*), which is the fourth pick in (*b*), no riser can be added to those in the spot figure, since it would not be possible to have a blank space between them; consequently, commencing with the next, or fifth, pick, mark the first end, which will leave a blank space between it and the first end marked in the spot figure on this pick. Running up this line in a regular 45° manner, it stops on the fourth end on the eighth pick. Continuing this line of risers completely around the spot, Fig. 46 (*c*) is obtained.



(*a*)



(*b*)



(*c*)

Fig. 46

EXAMPLES FOR PRACTICE

1. Make a twill weave with the base $\frac{3}{3}\frac{2}{2}\frac{1}{1}$.

2. From the weave given in answer to question 1 construct a weave by taking the ends in satin order, moving in sevens.

3. Construct a 15-end twilled basket.

4. Construct a rib weave that will make uneven ribs across the cloth.

5. Construct a rib weave that will make even ribs lengthwise of the cloth.

6. Make a twill weave with the base $\frac{8}{7}$, and from this twill construct a warp corkscrew weave; state the order in which the ends of the twill are taken to form the corkscrew.

7. Construct a honeycomb weave on 10 ends.

COMBINATION WEAVES

INTRODUCTION

1. One of the most common methods of producing new or novel weave effects in a fabric is by combining two or more weaves as a whole. In this method of amalgamating weaves, one or more repeats of each weave are joined together, instead of combining the weaves pick and pick or end and end. As twill, basket, satin, corkscrew or other weaves produce entirely distinct effects in a fabric, a large field is opened by this method for the production of new effects.

In the formation of combination weaves there are two important points that should be taken into consideration. In the first place, the yarns with which the cloth is to be woven, whether woolen, worsted, silk, or cotton, must be considered. If the yarn is woolen, the weaves must be uniform in structure, as woolen yarn is so constructed that it is not especially adapted for developing weave effects, the surface of the yarn being too rough and fibrous. Simple combinations and good colorings are the essential points in woolens.

In worsted or cotton fabrics, a large diversity of fancy weaves may be used, since the yarns are comparatively smooth (the fibers being laid in parallel order) and are thus excellently adapted for bringing out every detail of the weave. Silk is a still more suitable yarn for developing weave effects.

The second point, to which it is especially desired to call attention, is that however widely the weaves that are to be

combined may differ in respect to the effects that they produce in the cloth, they must be somewhat similar as regards the number of interlacings of the warp and filling, otherwise they cannot be made to weave together evenly. When desiring to form new effects by the method of combining two or more weaves, this latter fact should constantly be borne in mind, as it is absolutely essential to the satisfactory weaving of the cloth.

2. Fig. 1 is a representation of a sample of cloth made by combining two weaves without regarding the number of interlacings of warp and filling. The ends in (*a*) are interlaced on the 6-end-basket principle, while those in (*b*) are working plain, so that the ends in (*a*) interlace with the filling only four times in the 12 picks shown in this figure, while the ends in (*b*) interlace twelve times during the same number of picks. The result of this will be a tendency to prevent the picks of (*b*) from being as closely pressed against one another as those in (*a*), where the intersections are not so frequent. In (*b*) the warp yarn interlaces at every pick; therefore, the ends lie between one pick and the pick following, separating these by a distance nominally represented by the diameter of the warp yarn, and thereby preventing each pick from being beaten up against the preceding one. In (*a*), there is nothing to prevent one pick from being beaten up against the adjoining one in those places where the picks are three in a shed, supposing, of course, that this weave was being used

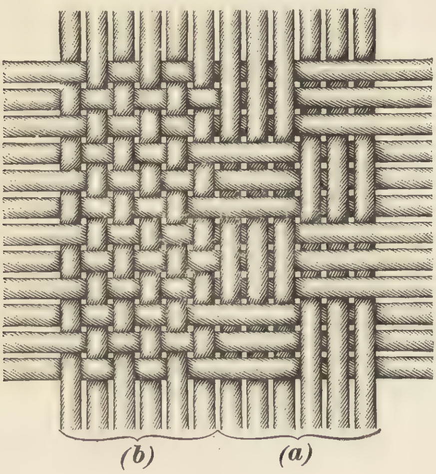


FIG. 1

alone irrespective of the weave used in (*b*); but between the third and fourth, sixth and seventh, ninth and tenth, and also the twelfth and first picks, the warp yarns change positions, and those lying between the third and fourth picks prevent these picks from being beaten up against each other, while the same is true in each of the other cases.

The more frequently the warp and filling interlace with each other, the greater difficulty there will be in driving each pick of filling closely against the preceding one; consequently, if the picks were beaten up close together in (*a*), the warp ends in (*b*) being deflected from a straight line to a much greater extent than those in (*a*), would take up faster and consequently work tighter during weaving, which would soon produce a cockled, or wrinkled, appearance. On the other hand, the more open the weave, the closer can the filling be inserted; for instance, as 3 ends of warp are depressed or elevated during 3 picks in succession in (*a*), this portion of the cloth admits the filling much more freely. For these reasons, closely woven and loosely woven weaves should rarely, if ever, be combined if the warp yarns are all run from the same beam, as they can be made to weave only with great difficulty. There are some instances, however, where unlike weaves may be combined without detriment to the regularity of the fabric, although these are the exception rather than the rule.

The ends and picks must interlace and form the build, or structure, of the fabric in addition to producing a design. Therefore, the practicability of a design in regard to its weaving should always be as carefully considered as the appearance of the woven cloth.

STRIPES AND CHECKS

STRIPE WEAVES

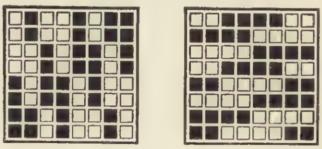
COMBINATIONS OF WARP- AND FILLING-FLUSH WEAVES

3. Stripes are continuous effects running lengthwise of the cloth, or in the direction of the warp. The most elementary form of a stripe obtained by a combination of weaves results from combining the warp prunelle with the filling prunelle. Fig. 2 is a stripe design complete on 18 ends resulting from combining these two weaves. The first 15 ends are made by repeating the warp prunelle $\frac{2}{1}$ five times, while the last 3 ends are the filling prunelle $\frac{1}{2}$. In combining weaves in this manner, it is always best wherever possible to make the weaves *cut* where they oppose each other. By **cutting** is meant that, where the weaves join, the warp floats of one weave will oppose, or come against, the filling floats of the other, and the filling floats oppose the warp floats. This has been done in Fig. 2. Thus, the fifteenth end is the last end of the warp prunelle, while the sixteenth end is the first end of the filling prunelle, and on those picks on which the fifteenth end is raised, the sixteenth end is lowered, while on those picks on which the fifteenth end is lowered, the sixteenth end is raised. But there is another joining point of these two weaves besides the fifteenth and sixteenth ends. If the weave should be repeated in its ends, the first end would come next to the last end. Therefore, when seeking to have weaves cut where they are joined, this point should be as carefully considered as the former. Fig. 2 complies with these requirements, since on those picks on which the last end is

Fig. 2

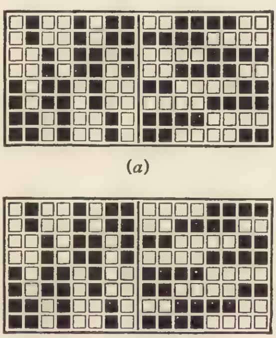
raised, the first end is lowered, while on those picks on which the last end is lowered, the first end is raised.

4. All weaves should run up in regular order and they should not be made irregular for the purpose of making the weaves cut, although they may be commenced on different ends and picks to attain this end. When weaves are combined and it is impossible to make them cut perfectly, always try so to combine the weaves that the warp and filling floats will not be any longer in the combination weave than they were in the separate weaves. To illustrate this point, suppose that it is desired to combine the two weaves shown in Fig. 3 (*a*) and (*b*). In the first case they will be combined just as they are; that is, by copying the 8 ends of Fig. 3 (*a*) for the first 8 ends of the new weave and copying the 8 ends of Fig. 3 (*b*) for the last 8 ends of the new weave. Fig. 4 (*a*) shows the weave formed by combining the two weaves by this method. On the third pick there is a filling float of 6 ends, while in neither of the weaves that were combined was there a filling float of more than 4 ends; also, on the seventh pick, 6 ends are raised side by side, while in neither of the weaves combined were there more than 4 ends up together on the same pick.



(*a*) (*b*)

Fig. 3



(*a*)

(*b*)

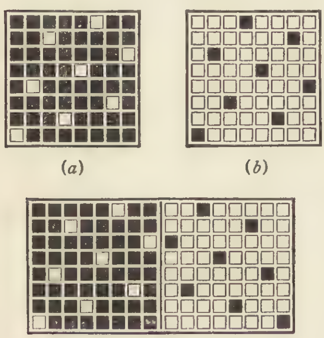
Fig. 4

Fig. 4 (*b*) shows another combination of these two weaves, but in this case on no pick does the filling float over a greater number of ends than it did in either of the weaves combined; neither are more ends raised together on any one pick. In this figure the first 8 ends are Fig. 3 (*a*), taken just as they are, while the last 8 ends are Fig. 3 (*b*), commencing with the seventh end and taking the ends in regular

order; that is, the ninth end of Fig. 4 (*b*) is the seventh end of Fig. 3 (*b*); the tenth end of Fig. 4 (*b*) is the eighth end of Fig. 3 (*b*); the eleventh end of Fig. 4 (*b*) is the first end of Fig. 3 (*b*); the twelfth end of Fig. 4 (*b*) is the second end of Fig. 3 (*b*), and so on.

It is not always possible so to combine two weaves that they will cut perfectly, nor in some cases so that there will not be any longer floats than in the individual weaves themselves; but the best manner of combining them should always be sought, since, if combined well, the resulting weave has a much better effect in the cloth. A description of the formation of a few of these weave combinations will be given in order to enable the method employed to be thoroughly understood.

5. One method of combination that is as satisfactory as any for certain classes of weaves is to combine two weaves, one of which is the reverse of the other in regard to the warp and filling flushing. These weaves can always be made to cut where they are joined. Thus, for example, suppose that two 8-end satin weaves are to be combined on this basis. Fig. 5 (*a*) shows an 8-end warp satin moving on a base of 3, while Fig. 5 (*b*) shows an 8-end filling satin moving on a base of 5. In making a combination weave from warp and filling satins, in order to have the weaves cut it is necessary to have the sum of the numbers used for the bases of the satins equal to the number of ends on which each satin weave is complete. Thus, in the case of Fig. 5 (*a*) and (*b*) the warp satin moves on a base of 3 while the filling satin moves on a base of 5, and $5 + 3 = 8$, which is the number of ends on which each satin weave is complete.



(*a*) (*b*)

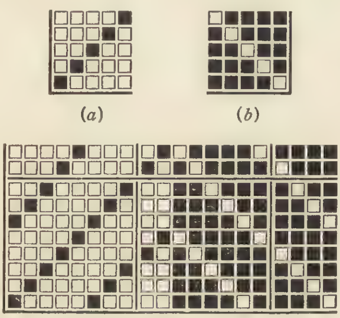
(*c*)

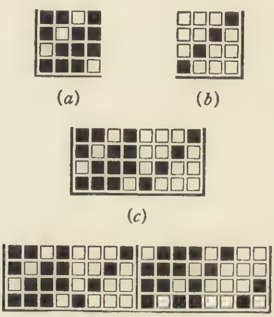
Fig. 5

It is next necessary to combine these two weaves in such a manner that they will cut, and since, if they were combined

as shown in Fig. 5 (*a*) and (*b*), the desired result would not be obtained, it will be necessary to start one of the weaves on either a different end or a different pick. By copying Fig. 5 (*a*) just as it is for the new weave, and starting Fig. 5 (*b*) on the second end, the weaves will be made to cut. Fig. 5 (*c*) shows these two weaves combined in this manner. Dealing with the second section of Fig. 5 (*c*) alone, the ninth end is the second end of Fig. 5 (*b*); the tenth end, the third end of Fig. 5 (*b*); the eleventh end, the fourth end of Fig. 5 (*b*); and so on.

6. Another good method of forming combination weaves with warp- and filling-flush weaves is to combine two twill weaves in one of which the warp flushes to an extent equal to the filling flushes of the other weave. Fig. 6 (*a*) and (*b*) are two such twill weaves, and by combining them as shown in Fig. 6 (*c*), they form a weave that cuts perfectly where the two weaves are joined. In Fig. 6 (*c*), both of the weaves that are combined have been repeated in both ends and picks.


(*a*) (*b*)
(*c*)
Fig. 6


(*a*) (*b*)
(*c*)
(*d*)
Fig. 7

In these figures, the twill in one figure runs in a direction opposite to the twill in the other; that is, the twill in Fig. 6 (*a*) runs to the right, while that in Fig. 6 (*b*) runs to the left. If it is desired to combine warp- and filling-flush twills in which the twill lines run in the same direction, it will be found necessary either to continue the weaves as a whole or else to continue one of the weaves for a portion of a repeat, in order to make them cut. For instance, suppose

that it is desired to combine Fig. 7 (*a*) with Fig. 7 (*b*) so that the width of each section of the stripe will be equal; that is, so that each will contain one repeat of the weave, or 4 ends in this instance. If this weave is made as shown in Fig. 7 (*c*), a perfect cut is not obtained between the eighth and first ends, but if it is continued as shown at Fig. 7 (*d*), the last, or sixteenth, end will cut perfectly with the first, and perfect cuts will also be made at all the other places where the warp-flush weave joins the filling-flush weave, or vice versa. In each section of Fig. 7 (*d*), the weaves shown in Fig. 7 (*a*) and (*b*) are used, but the sections that have been repeated are started on different ends, so as to make perfect cutting possible.

Another method of obtaining a perfect cut in a case like this is to continue one section for a number of ends sufficient to make a perfect cut; thus, 2 extra ends are added to the filling-flush weave in Fig. 8, or, in other words, a repeat and a half of this weave is used, which makes the last end of the weave work exactly opposite to the first, thus insuring a perfect cut. This method makes one stripe, in this case the filling-flush stripe, wider than the other. If even stripes are desired and the method employed in Fig. 7 (*d*) cannot be used, perfect cuts can be made by adding 1 end to both the warp- and the filling-flush section of the weave, as shown in Fig. 9. In this case a perfect effect in the cloth will be obtained, although even repeats of each weave will not be shown, each section having 1 end in excess of a repeat.

Fig. 8

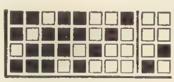


Fig. 9

COMBINATIONS OF EQUALLY FLUSH WEAVES

7. Very frequently stripe weaves are formed by using an equally flush twill as a chain draft and arranging the drawing-in draft so as to produce the required stripe effect. Fig. 10 (*a*) shows a stripe weave made in this manner, in which the first 4 ends are the cassimere twill $\frac{2}{2}$; the next 2 ends have the same interlacings as the second end; the

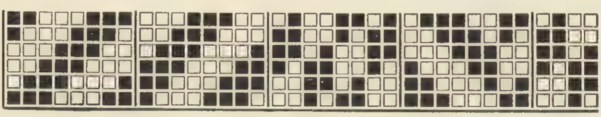
next 2 ends have the same interlacings as the fourth end; the next 8 ends are the regular twill commencing with the second end; the next 2 ends have the same interlacings as the third end; the next 2 ends have the same interlacings as the first end; while the last 2 ends are the cassimere twill commencing with the third end and running in regular order. It will be noticed that the last 2 ends are a continuation of the first 4 ends; that is, the last end does not cut with the first end but continues the weave regularly. In all other places where this weave changes, the ends cut. By this means a perfect stripe is obtained that is the same as though the $\frac{2}{2}$ basket were combined with the cassimere twill, yet the stripe may be obtained by using the cassimere twill as the chain draft and drawing the warp ends through the harnesses, as indicated by the drawing-in draft shown in Fig. 10 (*b*).

(*a*)

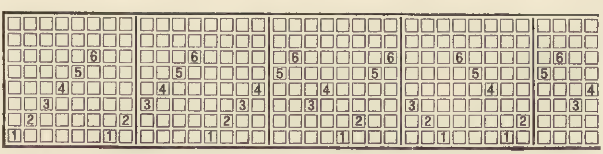
(*b*)

Fig. 10

Fig. 11 (*a*) is another stripe weave formed in a similar manner from the equally flush twill $\frac{3}{3}$. The first 18 ends of this stripe design are formed by running the regular twill $\frac{3}{3}$



(*a*)



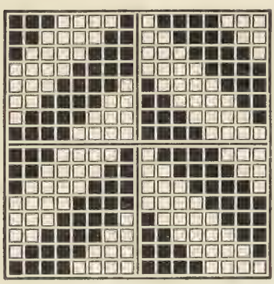
(*b*)

Fig. 11

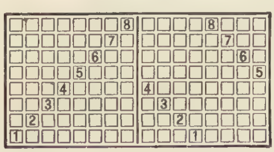
in regular order; the next 2 ends are the same as the third and fourth ends of the twill; the next 2 ends are similar to the first and second; and the next 2 ends are similar to the

fifth and sixth. The next 6 ends are the regular $\frac{3}{3}$ twill with the twill running in the opposite direction, and commencing with the third end. The next 2 ends are the same as the first and second ends; the next 2 ends are similar to the fifth and sixth; while the last 2 ends are similar to the third and fourth. In this case, as in the previous one, each end in Fig. 11 (*a*) is a certain end of the regular $\frac{3}{3}$ twill, and, consequently, it is possible to weave this design on 6 harnesses. The harness draft for Fig. 11 (*a*) on 6 harnesses is shown in Fig. 11 (*b*).

8. Another method of forming stripe weaves, and one that is quite generally adopted, is that of running a regular equally flush twill up for a certain number of ends and then reversing the weave, but commencing with an end that will cause the weave to cut where it is reversed. This effect may be obtained by using a regular equally flush twill weave as a chain draft with an angled drawing-in draft.



(*a*)



(*b*)

Fig. 12

Fig. 12 (*a*) shows a weave of this class, while Fig. 12 (*b*) gives the harness draft, which, it will be noticed, is an angled draft. In Fig. 12 (*a*), the weave is repeated in its picks, since 16 picks are shown, although the weave is really complete on 16 ends and 8 picks. At the ninth end it is reversed, and this end is the same as the fourth end; the weave also cuts at this point, as the warp and filling floats of the eighth end oppose the warp and filling floats of the ninth end. The warp and filling floats of the first end also oppose the warp and filling floats of the last end, thus causing the weave to cut at this point, since these 2 ends come together in the cloth.

The width of either section of the stripe can readily be changed by repeating that section of the drawing-in draft.

Thus, if the first 8 ends of the drawing-in draft were repeated four times and the last 8 ends were not repeated, the first section would be complete on 32 ends and the last section on 8 ends, the whole weave being complete on 40 ends, although it would require only the same number of harnesses to weave it, namely 8 harnesses. By changing the drawing-in draft in this manner, a large number of different weaves can readily be formed, and by changing the twills in the weave, a still greater variety can easily be obtained.

SINGLE-END STRIPES

9. Another class of stripe designs that is met with quite frequently includes weaves known as **single-end stripes.** These weaves are generally formed by opposing a warp-flush weave with a single end of a filling-flush weave, or vice versa, having the ends cut where the two weaves oppose each other; the effect of this is to form a *cut mark*, or fine indented line, which is generally arranged to run warp way of the cloth. Fig. 13 illustrates one of these weaves; the first end is an end of a filling-flush weave; the next 6 ends are the regular $\frac{2}{1}$ warp-flush twill; the next end is a filling-flush end; the next 6 are the $\frac{2}{1}$ twill; the next end is a filling-flush end; and the last 3 are the $\frac{2}{1}$ twill.

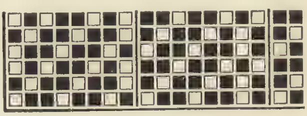


Fig. 13

Where the weaves are combined they cut on both sides of the single end, and in order to accomplish this it is necessary to have the end on one side of the single end of the filling flush exactly like the end on the other side. Thus, the seventh and ninth ends of the weave illustrated are the same, also the fourteenth and sixteenth, and also the second and eighteenth.

EXAMPLES FOR PRACTICE

1. Make a stripe design on 12 ends by reversing the 6-end twill $\frac{3}{3}$; have the weaves cut where they reverse.

2. Make a single-end stripe design on 20 ends, using the 4-end twill $\frac{3}{1}$.

3. Make a stripe design on 14 harnesses, using warp- and filling-flush satins; have the weaves cut where combined.

4. Make a stripe design on 20 ends, using the 5-end warp and filling satins repeated in the ends.

5. Give a harness draft complete on 24 ends that will give a stripe effect in the cloth when using the $\frac{6}{6}$ twill for a chain draft.

CHECK-WEAVES

COMBINATIONS OF EQUALLY FLUSH WEAVES

10. Check-weaves may be made in a variety of ways, many of these weaves having a twill or satin base. In many cases the figure on one part of the check will be found to be produced by the warp, while the figure on the other part will be produced by the filling. Check-weaves to a certain extent may be considered as simply extensions of stripe weaves. It has been explained how a stripe may be formed in the cloth by opposing one weave with another; if, after this is done, the weave should be extended in its picks, taking pains to have the picks oppose one another in the same way as the ends were opposed in the stripe weave, the resulting figure will form a check in the cloth.

11. Suppose, for example, that it is desired to make a check-weave with the regular equally flushed weave shown in Fig. 14 (*a*) as a base. First, it is necessary to form a stripe design from the regular twill. Fig. 14 (*b*) shows the stripe design formed from the regular twill shown in Fig. 14 (*a*). The formation of this weave agrees with the descriptions given, and the harness draft for it will be an angled draft. Next consider the stripe as two separate sections, that is, the first 6 ends will be one section and the last 6 ends will be another, after which extend each section in its picks, taking care to have the weaves cut in the picks the same as in the ends when forming the stripe. In other words, extend each section as if it were to form a stripe across the cloth instead of lengthwise. Fig. 14 (*c*)

shows the first 6 ends extended in this manner, while Fig. 14 (*d*) shows the last 6 ends extended. The weaves cut perfectly in their picks, since in both weaves the sixth pick opposes the seventh, and the first and last picks oppose each other. In actual practice the picks in each of the two sections of the weave, as shown in Fig. 14 (*b*), would be run up without separating the weaves; they have been separated here simply to make the process clearer. Therefore, the complete check-weave will be the weave shown in Fig. 14 (*e*), which is Fig. 14 (*c*) and (*d*) brought together.

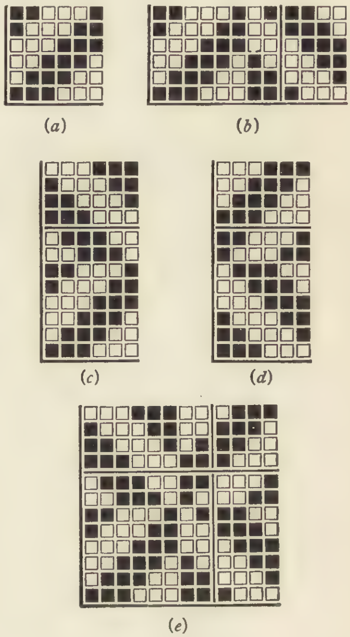


FIG. 14

An important point that should be noted in connection with this check is that the weave cuts all around; that is, the sixth pick opposes the seventh pick; the sixth end opposes the seventh end; and, further, the first and last picks, and also the first and last ends, oppose each other. This feature should be present in check-weaves formed in this manner.

The same harness draft that would be used in connection with the weave shown in Fig. 14 (*b*) would also be used for the weave shown in Fig. 14 (*e*). Therefore, in actual practice, when it is desired to change a stripe weave to a check, all that is necessary is simply to alter the chain draft to give the desired effect. With stripes formed on this principle, the size of the stripe can be enlarged to any desired extent by simply altering the drawing-in draft. The same rule holds good when dealing with checks formed in this manner, with the exception that in the latter case the chain draft must also

be altered, that is, the size of the check may be increased as desired by changing the drawing-in draft and chain draft to suit the requirements. Fig. 15 illustrates a design formed by this method of enlarging a check-weave; it has been formed by simply extending each section of Fig. 14 (*e*) in both ends and picks. Take, for example, the section occupying the lower left-hand corner in both Figs. 14 (*e*) and 15. Both of these weaves are the same, the only difference being that while in one case the weave occupies 6 ends and 6 picks, in the other it occupies 12 ends and 12 picks. The same has been done with each of the four sections, thus causing the new weave to occupy 24 ends and 24 picks, where it originally occupied but 12 ends and 12 picks. The weave shown in Fig. 14 (*e*) can be made on 6 harnesses, which is the same number on which Fig. 15 can be woven.

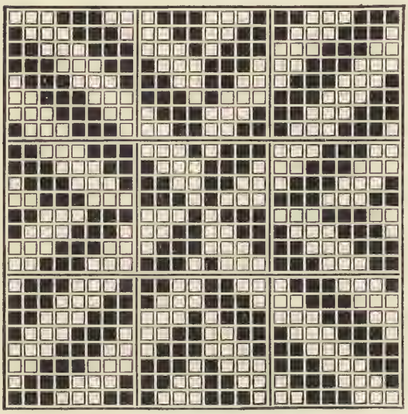


Fig. 15

12. Stripes may be formed in a variety of ways, not only by equally flushed twills but also by opposing a warp-flush twill with a filling-flush twill. The same is equally true of checks and, consequently, a check-design may readily be formed from a stripe design that has been obtained by combining warp- and filling-flush twills. Fig. 16 is an example of this type of check-designs. The first 8 picks of this design alone form a stripe design, obtained by combining the warp-flush twill $\frac{3}{1}$ with the filling-flush twill $\frac{1}{3}$.

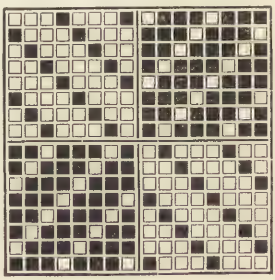


Fig. 16

The next 8 picks are formed by opposing the warp-flush section with the filling-flush weave and the filling-flush section with the warp-flush weave. This weave cuts perfectly at all points.

13. Warp- and filling-satin weaves are often combined to form stripe weaves, and these also may be extended to check-weaves and made to cut at all points. Fig. 17 is an example of a cut check-weave made from warp and filling satins. When combining weaves of this class to form a check, the explanations given for stripe weaves made by combining satins should be carefully noted, especially with regard to the relation that the base of the warp satin should bear to the base of the filling satin in order to make the weaves cut at all points, and also with regard to starting the weaves on certain ends and picks for the same purpose. In Fig. 17, the eighth and ninth ends and the first and last ends, also the eighth and ninth picks and the first and last picks, cut perfectly, since in each case the warp and filling floats of one weave oppose the filling and warp floats of the other.

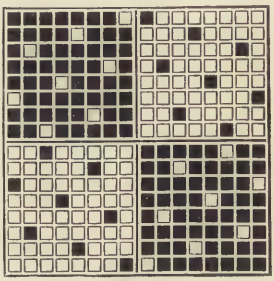


FIG. 17

It will be found advantageous to practice making these weaves, as well as all weaves that are explained in this Course, as it is only by constant practice that familiarity with the methods employed can be obtained. In making a check-weave, it is simply necessary to decide on the weave that is to form the base and run this weave up for as many ends and picks as desired. From this weave, form a stripe design by following the explanations given for stripes and afterwards extending the weave in its picks to form a check, always being careful, however, to see that the weaves cut at all points. Check-weaves constructed after the manner of Figs. 16 and 17 are known as **diaper weaves.**

CHECKS FORMED BY REVERSING

14. Another method of forming checks is by means of what is termed **reversing,** or **transposing,** and consists of taking any simple weave as a base and combining it with a weave that contains filling floats where the original weave has warp floats and warp floats where the original has filling floats. The combination of these weaves will make a stripe from which a check may be formed by reversing or transposing the stripe design in the same manner as the original weave was transposed to obtain the stripe.

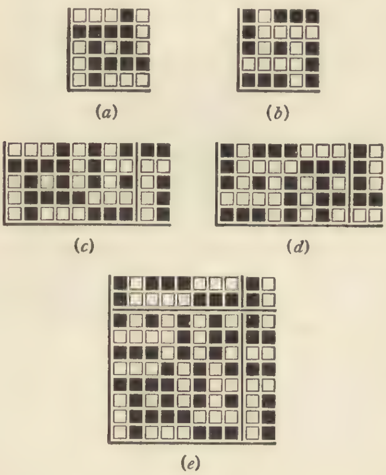
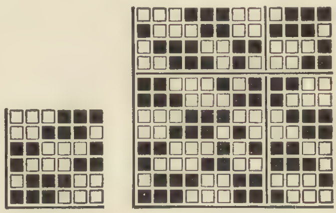


Fig. 18

To illustrate this method of forming checks, suppose that it is desired to form a check-weave using the weave shown in Fig. 18 (*a*) as a base. This figure occupies 5 ends and 5 picks; taking the next 5 ends and 5 picks across the design paper, fill in those squares that correspond to the squares left blank in the original figure, leaving blank those squares that were filled in in the original figure. In order to make this somewhat plainer, the weave will be made from Fig. 18 (*a*), keeping the weaves separate, although in reality they should be combined when making the stripe design. Fig. 18 (*b*) shows the weave obtained by transposing the weave shown in Fig. 18 (*a*). In transposing a weave in this manner to form a stripe, the first end of the new weave is to be the reverse of the last end of the original weave; the second end of the new weave is to be the reverse of the next to the last end of the original; and so on.

Considering Fig. 18 (*a*) and (*b*), the last, or fifth, end of Fig. 18 (*a*) is lowered on the first pick, raised on the second

pick, and lowered on the third, fourth, and fifth picks. The first end of Fig. 18 (*b*) is exactly the reverse, since it is raised on those picks on which the fifth end of Fig. 18 (*a*) is lowered, and is lowered on those picks on which the fifth end is raised. The fourth end of Fig. 18 (*a*) is exactly the reverse of the second end of Fig. 18 (*b*), since on those picks on which one end is raised the other end is lowered, and also on those ends on which one end is lowered the other end is raised. The same is true with the third end of Fig. 18 (*a*) and the third end of Fig. 18 (*b*); with the second end of Fig. 18 (*a*) and the fourth end of Fig. 18 (*b*); with the first end of Fig. 18 (*a*) and the last end of Fig. 18 (*b*). Thus, if these two weaves were combined to form a stripe, they would be found to cut perfectly. Fig. 18 (*c*) shows the stripe weave formed in this manner.



(*a*) (*b*)

FIG. 19

It next becomes necessary to form a check-design from the stripe shown in Fig. 18 (*c*). In order to form this weave, the stripe must be extended in its picks by reversing the picks. This will be dealt with in the same manner as when forming the stripe from the original weave. Fig. 18 (*d*) shows the weave formed from the stripe that must be combined with it to make the check. This weave is formed by reversing the picks of Fig. 18 (*c*) in the same manner as Fig. 18 (*b*) was formed by reversing the ends of Fig. 18 (*a*). Thus, the first pick of Fig. 18 (*d*) is the reverse of the fifth pick in Fig. 18 (*c*); the second pick of Fig. 18 (*d*) is the reverse of the fourth pick of Fig. 18 (*c*); the third pick of Fig. 18 (*d*) is the reverse of the third pick of Fig. 18 (*c*); and so on for all the picks.

By combining these two weaves, the check-design shown in Fig. 18 (*e*) is obtained, which cuts at all points. Fig. 19 (*a*) is another base from which to form a check-weave after the manner described, while Fig. 19 (*b*) shows the completed weave. This weave also cuts at all points—a feature that

is always desirable with these weaves. Check-weaves are produced by a variety of methods. It is not necessary always to have the different weaves that form the check cut perfectly, although much neater and clearer effects are produced when this is the case.

COMBINATIONS OF WEAVES OF DIFFERENT STRUCTURE

15. Another method of forming check-weaves is that of combining different weaves in such a manner that distinct effects will be formed in the cloth, so arranged that the whole will produce a check. Fig. 20 shows a check-weave formed in this manner. The whole figure may be divided into four parts; namely, the lower left-hand corner, the

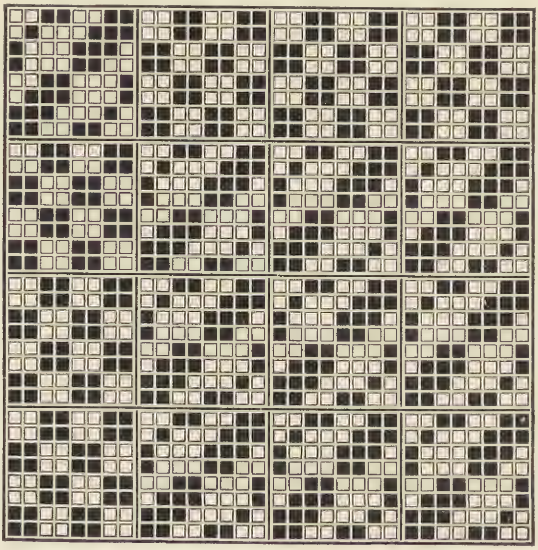


Fig. 20

lower right-hand corner, the upper left-hand corner, and the upper right-hand corner. The weave in the lower left-hand corner is the regular 4-end basket repeated twice in its ends and six times in its picks; the weave in the upper right-hand corner is the same, but instead of occupying the same number of ends and picks in this case, it is repeated

six times in its ends and twice in its picks. The weave in the upper left-hand corner is a fancy twill complete on 8 ends and 8 picks, while in the lower right-hand corner the same weave is repeated three times in both ends and picks. By combining these weaves in this manner, a distinct check

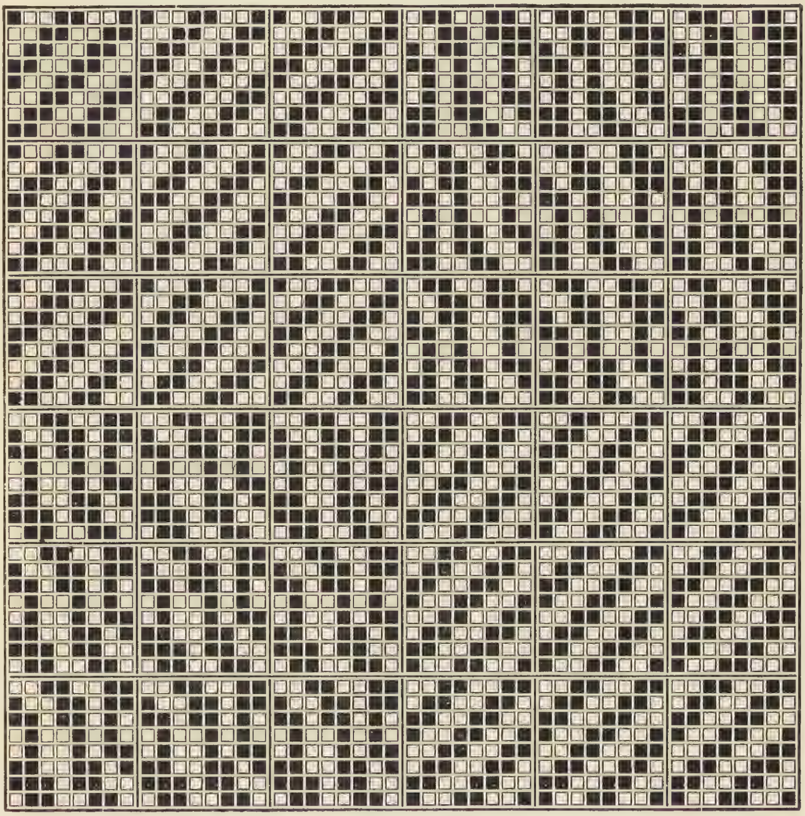


FIG. 21

effect is formed in the cloth, and they cut perfectly where joined. Although this weave occupies 32 ends and 32 picks, it is possible to draft it down to 16 harnesses.

Checks formed by combining different weaves in this manner are more difficult to construct than those previously

described, on account of the difficulty in finding weaves of different constructions that will cut perfectly. In all cases, perfect cuts are not obtainable in this class of checks, but the joining places should always be made as perfect as possible and the weaves should be combined in such a manner that the floats of warp or filling will not be any longer than possible.

16. Check-weaves are sometimes formed by combining twill weaves that form different angles in the cloth. Fig. 21 is an example of this class of weaves, in which the check is formed by combining a cassimere twill that makes an angle of 45° with a fancy upright twill complete on 8 ends and 8 picks. The weave is complete on 48 ends and 48 picks, but can be drawn and woven on 16 harnesses. Check-weaves made on this principle can very rarely be made to cut perfectly all around, as is the case with Fig. 21.

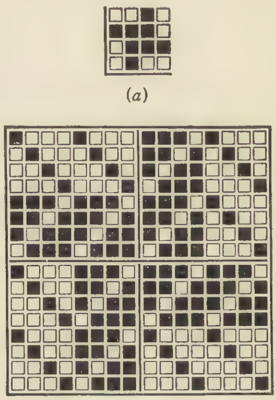
WEAVES RESULTING FROM OTHER COMBINATIONS

WEAVES FORMED FROM MOTIVES

17. When weaves are to be combined so as to produce a more or less elaborate pattern instead of a simple arrangement as in stripes and checks, the order or method of their arrangement is usually indicated by a *motive*. A **motive** as considered in this connection is a weave figure that shows the arrangement of the separate weaves in the combination weave. It may be defined as a plan, or skeleton, of the desired pattern that may be enlarged into an extensive design; the motive simply shows the general arrangement of the pattern, but gives no idea of the ultimate extent of the resultant combination weave nor of what weaves are to be combined. In using a motive as a plan for combining weaves, the filled squares of the motive are assumed to represent one of the weaves to be combined and the blank

squares another weave, the combination weave being made of any desired size by extending the motive.

For instance, Fig. 22 (*a*) shows a motive from which it is desired to produce a design that will be complete on 16 ends and 16 picks. The motive occupies 4 ends and 4 picks, and the filled-in squares and the blank squares of the motive represent two distinct weaves. The first item to be determined when constructing a weave from a motive is the number of ends and picks occupied by the weave that is represented by each square of the motive. Thus, since the constructed weave is to occupy 16 ends and 16 picks, while the motive occupies 4 ends and 4 picks, each square of the motive must represent 4 ends and 4 picks of the constructed weave ($16 \div 4 = 4$), or, in other words, the weave represented by each square of the motive must occupy exactly 4 ends and 4 picks, in order to make the constructed weave complete on 16 ends and 16 picks.



(*a*)

(*b*)

Fig. 22

It will be assumed that each blank square of the motive represents the filling crow twill $\frac{1}{3}$, while each filled-in square of the motive represents the warp crow twill $\frac{3}{1}$. It now remains to combine these weaves in such a manner that they will occupy the same relative positions in the constructed weave that the filled-in and blank squares occupy in the motive. Fig. 22 (*b*) shows the weave made in this manner from the motive shown in Fig. 22 (*a*). Comparing these views, the square in the lower left-hand corner of the motive is blank; therefore, the first 4 ends and 4 picks of Fig. 22 (*b*) are composed of the filling crow twill. The next square of the motive counting across the page is marked; therefore, the next 4 ends and 4 picks are composed of the warp crow twill. This method is continued throughout the weave, and the effect when produced in the cloth will be similar to the motive shown in Fig. 22 (*a*).

EXAMPLES FOR PRACTICE

1. Make a check-weave on 16 ends and 16 picks with the $\frac{4}{4}$ twill.

2. Enlarge the weave given in answer to question 1 so that it will occupy 32 ends and 32 picks.

3. Form a check-weave with a 5-end warp-flush and a 5-end filling-flush satin.

4. Form a check-weave by reversing weave 32, *Glossary of Weaves*.

5. Considering weave 200, *Glossary of Weaves*, as a motive, construct a weave on 32 ends and 32 picks, using the filling-flush crow twill for the filled-in squares of the motive and the warp-flush crow twill for the blank squares.

FOUR-CHANGE METHOD OF CONSTRUCTING NEW WEAVES

18. New and novel weaves may be constructed from simple foundation weaves by means of what is known as the **four-change method.** Some of the weaves thus obtained will be found to be granite weaves, while others partake of the nature of small fancy twills. In constructing a new weave by four changes, a simple weave of regular structure, such as the cassimere twill, the crow weaves, 6-, 7-, or 8-end twills, etc., should be selected as a foundation. It is also important to select a weave for a base that repeats on the same number of ends as picks. The new weave obtained will always be complete on twice as many ends and picks as the foundation weave; thus, if a weave is used for a base that is complete on 6 ends and 6 picks, the derived weave will occupy 12 ends and 12 picks.

To illustrate this method of originating weaves, suppose that it is desired to construct a new weave from the cassimere twill, Fig. 23 (*a*). Since the cassimere weave is complete on 4 ends and 4 picks, the new weave in this case will occupy 8 ends and 8 picks. The first step is to place the foundation weave on design paper in such a manner that each end of the weave is separated from the next by 1 blank end, and each

pick from the next by 1 blank pick, as shown by the *1*'s in Fig. 23 (*b*). The design paper is then turned one-quarter way around to the right, that is, so that the last end will be in the position of, and considered as, the first pick, and the same weave placed on the design in exactly the same relative position as in the first instance, as shown by the *2*'s in Fig. 23 (*c*). The design paper is then turned a quarter way around again, that is, so that the last pick in Fig. 23 (*b*) will occupy the position of, and be considered as, the first pick, and the weave again placed on the design in exactly the same manner, as shown by the *3*'s in Fig. 23 (*d*). The design

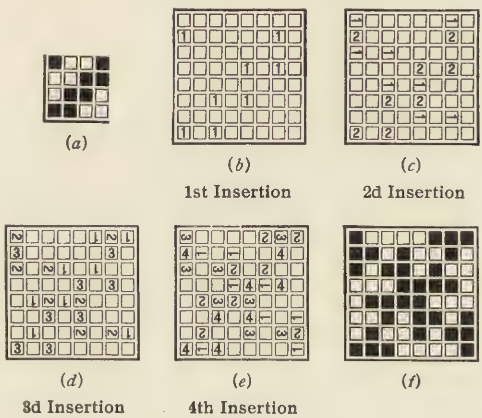
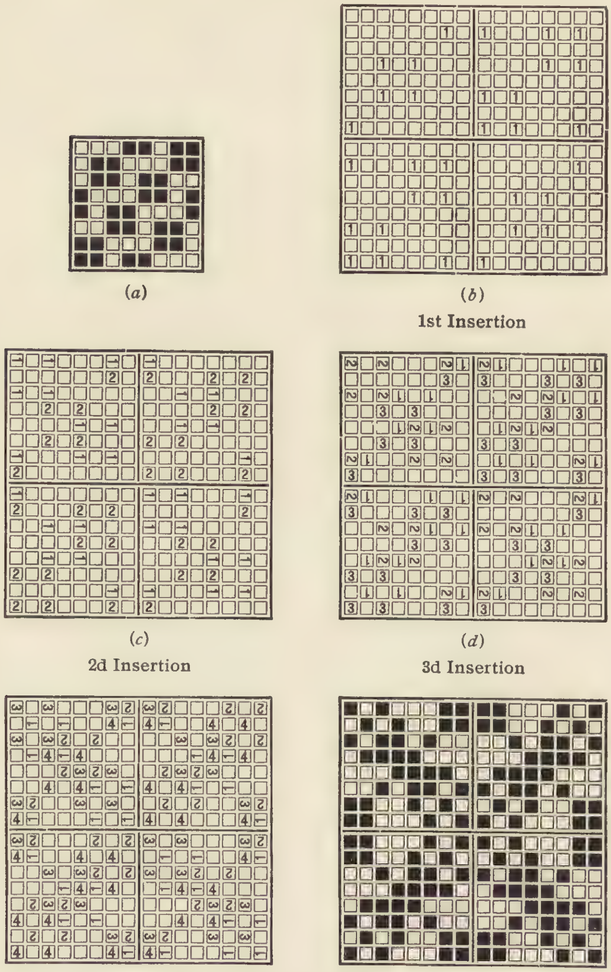


FIG. 23

paper is then turned in the same direction another quarter revolution, so that the first end will occupy the position of, and be considered as, the first pick, and the same weave inserted for the fourth and final time, as shown by the *4*'s in Fig. 23 (*e*). In Fig. 23 (*b*), (*c*), (*d*), and (*e*), numbers are used instead of filled squares, so that each insertion of Fig. 23 (*a*) may be clearly indicated in its proper relative position. Considering each number in Fig. 23 (*e*) to represent a riser, or filled square, the new weave as shown in Fig. 23 (*f*) will result; that is, Fig. 23 (*f*) shows every numbered square in Fig. 23 (*e*) as a filled square, and is the completed derived weave.

Each time a quarter revolution is given to the design paper, the square in the lower left-hand corner is considered



(a)

(b) 1st Insertion

(c) 2d Insertion

(d) 3d Insertion

(e) 4th Insertion

(f)

Fig. 24

as the square representing the crossing of the first end and first pick, and the weave is placed accordingly on the design

paper in its proper position. If this is done, and the weave properly inserted each time so that each end and pick is separated by one other end and pick, it will be found that no two marks or risers will fall on the same square, but each will find a blank square of its own in which to be placed. If an equally flushed weave is used as a foundation weave, the derived weave will also show an equal amount of warp and filling on the face, and if the foundation weave is unequally flushed, the derived weave will show the warp and filling on the face in the same proportion as the foundation weave.

19. As a further illustration of this method of originating weaves, suppose it is desired to make a new weave with the 8-end twilled basket, Fig. 24 (*a*), as a foundation weave. Since this weave is complete on 8 ends and 8 picks, the new weave obtained from it will occupy 16 ends and 16 picks. Fig. 24 (*b*) shows the foundation weave opened out and placed on the design paper in the proper manner. Fig. 24 (*c*) shows the weave again inserted in the design but with the last end considered as the first pick. Fig. 24 (*d*) shows the weave inserted the third time, with the last pick considered as the first, while Fig. 24 (*e*) shows the weave inserted for the fourth time, with the first end considered as the first pick, which completes the weave. Fig. 24 (*b*), (*c*), (*d*), and (*e*) are not shown in the same relative position, since, as indicated by the position of the original weave in each figure, the design has been turned one-quarter way around for each insertion of the weave. Fig. 24 (*f*) shows the completed weave, which is a novel fancy diamond effect.

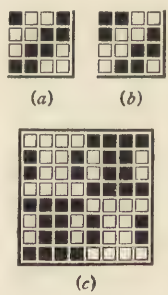
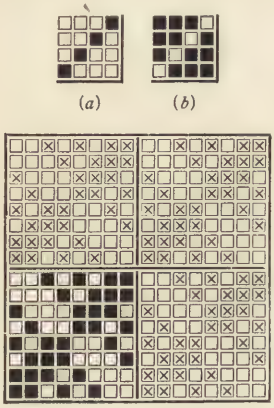


FIG. 25

20. In many cases entirely different effects are produced by using the same foundation weave, but, when inserting it the second and fourth times, commencing on a different pick, so that the relation of the weave to the first and third insertions is changed. For instance, take the effect formed with the cassimere twill as a foundation weave. If this weave

is inserted as shown in Fig. 25 (*a*) the first time, then turned one-quarter way around and the same weave inserted but commenced on the second pick, as shown in Fig. 25 (*b*), then turned again and Fig. 25 (*a*) inserted, and finally turned and Fig. 25 (*b*) inserted, the weave shown in Fig. 25 (*c*) will be obtained. This effect is entirely different from that shown in Fig. 23 (*f*), and yet is produced from the same foundation weave, the relation of the insertions of the foundation weave being changed.



(*a*) (*b*)

(*c*)

Fig. 26

New weaves may also be originated by combining warp- and filling-flush weaves. For instance, suppose that it is desired to produce a new weave using the filling-flush crow weave, Fig. 26 (*a*), and the warp-flush crow weave, Fig. 26 (*b*), as foundation weaves. First, the filling-flush weave is opened out and placed on the design paper, the weave in this case occupying 8 ends and 8 picks. The design paper is then turned one-quarter way around and the warp-flush weave inserted, then another quarter revolution and the filling-flush weave inserted again, and finally another quarter revolution and the warp-flush weave inserted, which results in the weave shown in Fig. 26 (*c*). The weave obtained in this manner may also be varied by commencing one of the weaves on another pick. Fig. 26 (*c*) shows two repeats both in the warp and filling.

EXAMPLES FOR PRACTICE

1. Originate a new weave with the $\frac{2}{1}\frac{1}{2}$ regular twill as a foundation weave.

2. Originate a new weave with the $\frac{2}{3}$ regular twill as a foundation weave.

3. Originate a new weave with the $\frac{3}{2}\frac{2}{1}$ regular twill as a foundation weave.

4. Originate a new weave with the warp- and filling-flush broken crow weaves as foundation weaves.

5. Originate a new weave with the warp- and filling-flush 5-end satin weaves as foundation weaves.

CONSTRUCTION OF SPOT WEAVES

SPOT WEAVES FORMED WITH ONE SYSTEM OF WARP AND FILLING

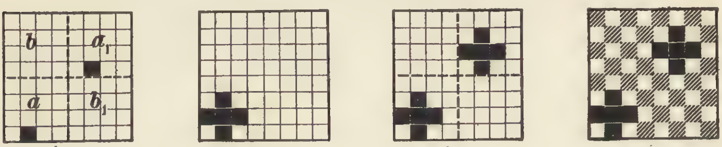
WARP-SPOT WEAVES

1. Weaves that produce fabrics of a spotted character, that is, cloths with spots distributed over the face, are known as **spot weaves.** These weaves are formed by bringing a certain series of yarn, either the warp or the filling, to the surface of the cloth at certain points and allowing it to float for a number of ends or picks, as the case may be, thus producing a spotted effect on the cloth. The manner in which the yarn is allowed to float on the face will determine the shape and appearance of the spot, and the places where these floats are made will determine the arrangement, or distribution, of the spots on the surface of the fabric. Spots may be made by floating either the warp or the filling on the face of the cloth; the former are known as **warp spots,** and the latter, as **filling spots.**

The first consideration when making a spot weave is the arrangement, or order of distribution, of the spots on the surface of the cloth. Spots may be arranged in plain order, satin order, broken crow order, etc.; by this is meant that the spots appear on the surface of the cloth in the same order, that the ends are either raised or depressed in a plain, satin or broken crow weave, as the case may be. For

example, if spots are distributed over the surface of a fabric in the same relative position to one another as the risers of the plain weave, they are said to be arranged in plain order, or if they are distributed in the same order as the risers of the 5-end, filling-flush, satin weave, they are said to be arranged in 5-end satin order, etc.

2. To illustrate the method of producing spot weaves, suppose that it is desired to make a warp-spot weave on 8 ends and 8 picks, the spots to be arranged in plain order. Since the spots are to be arranged in plain order, there will be two spots in each repeat of the weave, just as there are two risers in one repeat of the plain weave, and the 8 ends and 8 picks on which the whole weave is to be complete must first be divided into four sections, each containing sixteen small squares of the design paper. Fig. 1 (a) represents



(a) (b) (c) (d)

FIG. 1

8 ends and 8 picks of design paper thus divided by heavy dotted lines. Since the spots when arranged in plain-cloth order appear on the face of the cloth in a manner similar to the ends in a plain weave, the two spots may be placed in sections a, a_1, while sections b, b_1 are reserved for the ground weave.

Before placing the spots in their respective sections, it is best to mark one of the small squares in each section in which the spots are to be placed, these marks to be placed in squares having the same relative position in each section. Thus, in Fig. 1 (a), one square of section a and one of a_1 have been filled in. It is next necessary to determine the spot figure to be used, as a spot must be selected that does not occupy so many ends and picks that two of the spots will run into each other. Since in this case the entire weave is

to be complete on 8 ends and 8 picks, the spot figure cannot occupy many ends and picks, and therefore a simple figure similar to that shown in Fig. 1 (*b*) must be selected.

Although it is not necessary to start the spot weave on any particular end or pick, it must be commenced on the same relative end and pick in both sections *a* and a_1, Fig. 1 (*a*). This is the object of the filled-in squares in each of these sections; that is, to give a starting point when placing the spot figure on the design paper, so that each spot will occupy the same relative position in its section. For example, suppose that the lowest square of the spot is to occupy the square that is marked in section *a*, Fig. 1 (*a*). Then, if this is done in section *a*, it must also be done when placing the spot in section a_1, and by so doing the spots will have the same relative position in the weave and be equally distant from each other; by marking certain squares as in Fig. 1 (*a*), the correct position of the different spots is readily obtained. It next becomes necessary to place the spots on the design paper. The method spoken of, that is, considering the squares marked in Fig. 1 (*a*) as the lowest marked square of the spot, will be adopted in placing this spot on the design paper. Fig. 1 (*c*) shows the spot figure placed on the design paper in this manner; each spot occupies the same relative position in the section in which it is placed, and if three or four repeats of this figure in both ends and picks are worked out, it will also be apparent that there is the same distance between the spots.

3. After the spots have been placed on the design paper, as shown in Fig. 1 (*c*), the blank spaces must be filled in with some simple weave, known as the **ground weave,** in order to give the fabric the required firmness of texture. It would be impossible to construct a fabric exactly as shown in Fig. 1 (*c*), since the fourth and eighth ends and picks are not interlaced with the fabric, and even if the fabric could be thus woven it would be too loosely constructed to be serviceable. When selecting a ground weave to be used with a spot figure, a weave should be selected that will match up well

with the spot; that is, one that will not allow large floats of warp or filling in any part of the cloth. The most useful weaves for this purpose are the plain weave, the twills, and satins. A small, simple, and regular weave can generally be used to the best advantage as a ground weave, and should therefore be selected. It is not always possible to find a weave that will neither run into the spot figure nor leave a larger float in some places than in others. In the example under consideration, it will be assumed that the plain weave is to be used for the ground weave.

In placing the ground weave in a design of this kind, the first square to be marked with a riser should always be carefully selected. Thus, for example, with the illustration being used, suppose that the first riser of the plain weave were marked in the upper right-hand corner of Fig. 1 (*c*); then the next riser would come in contact with a riser in the spot, which should always be avoided, if possible, while, on the other hand, if this next square were skipped without being marked, there would be a float at this point longer than the average float in the rest of the ground weave. However, by beginning the plain weave in the upper left-hand corner and marking this square with a riser, the ground weave will not interfere in any way with the spots. Fig. 1 (*d*) shows the completed weave with the ground inserted in this manner; in no place does the plain weave run into the spot, and the floats of both warp and filling are of an equal length in the ground.

When spots are placed on a plain ground, it will often be found necessary to move one or more spots 1 end or 1 pick out of position, in order to make the plain weave join the spot in the proper manner. This is always advisable when the spots are placed some distance apart, since a slight displacement of the spot will hardly be noticed, while, if the ground weave does not join the spot properly, the entire design is spoiled. Fig. 1 (*d*) serves as an illustration of the manner of constructing spot weaves rather than as an especially meritorious example of such weaves; for, since it is complete on 8 ends and 8 picks, and since two spots have to be placed in this space, it is not possible for the spots to

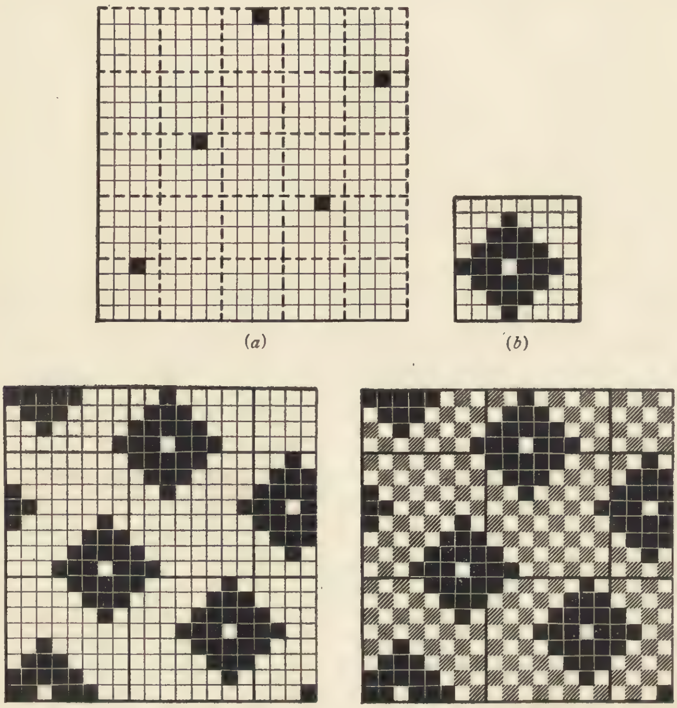
occupy a very large number of ends and picks, while in order to have a spot weave appear well in the cloth, the spot figure should occupy a comparatively large number of ends and picks. Most spot weaves will, consequently, be found to extend for some distance before repeating. It will also be noted that in many of the spot weaves shown in this Section the spots are placed comparatively close together, but spot weaves are often arranged with the spots a considerable distance apart. The same principles of construction apply, however, as are herein described, and it is only necessary to insert as many ends and picks of the ground weave as desired between the spots in order to distribute them any required distance apart on the face of the cloth.

4. As a further illustration of the method of constructing spot weaves, suppose that it is desired to construct a spot weave on 20 ends and 20 picks and that the spots are to be arranged in 5-end satin order. This will necessitate five spots being placed in one repeat of the weave, and therefore the design paper containing the squares on which the complete weave is to be placed must first be divided into five sections each way, thus producing twenty-five sections in all, as shown in Fig. 2 (*a*). In this illustration heavy dotted lines are used to separate the sections, and as certain of these lines coincide with the heavy lines of the design paper, the latter have been omitted. In practice, pencil lines may be used to divide the design paper into sections, as they may be made more quickly, and the only purpose is to divide the weave into imaginary sections. In Fig. 2 (*a*) certain of the sections, taken in 5-end satin order, have each been marked with a small square.

The next thing to be considered is the spot that will be placed on the design, as one must be selected that will not be so large as to interfere with other spots nor so small as to be obscure when the fabric is woven. It will be assumed that the spot shown in Fig. 2 (*b*) is to be used. The spots must be placed on the design paper in such a manner that they will be arranged in satin order, and be equally distant from each

other. By taking as a guide on which to build these spot figures the marked squares of Fig. 2 (*a*), which were placed on the sections in satin order, the desired result will be obtained.

It will be assumed that the squares marked in Fig. 2 (*a*) represent the topmost riser of the spot shown in Fig. 2 (*b*);



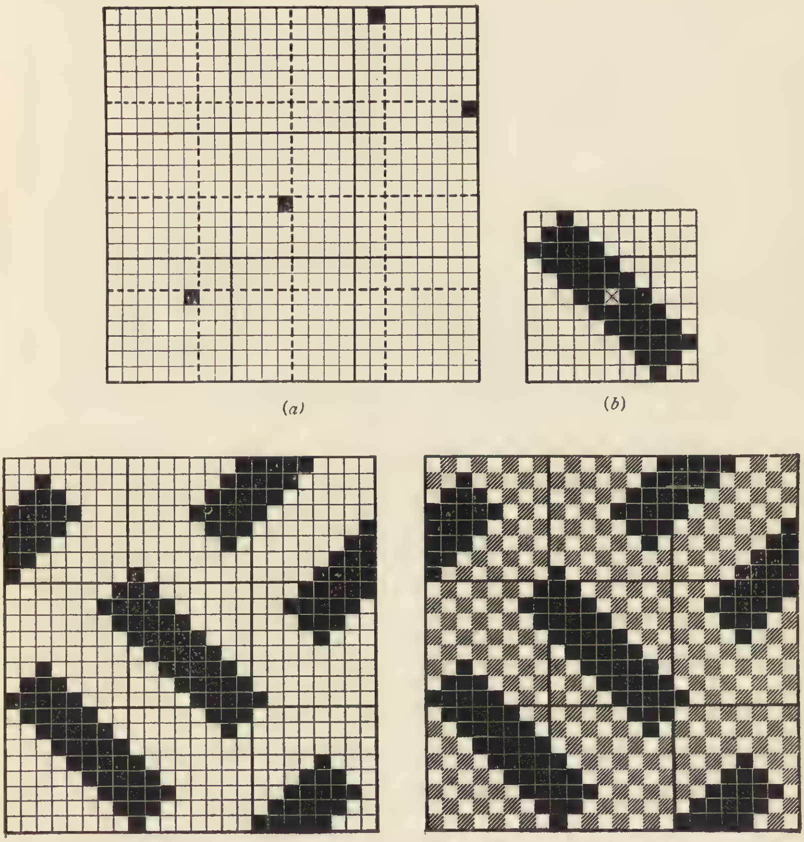
(*a*) (*b*) (*c*) (*d*)

FIG. 2

then completing each spot, the 5-end satin arrangement of the spots shown in Fig. 2 (*c*) is obtained. The plain weave makes a very suitable ground weave for this design, and by inserting it properly, the completed design shown in Fig. 2 (*d*) is obtained.

5. As another example of spot-weave construction, suppose that it is desired to construct a spot weave on 24 ends and 24 picks, the spots to be arranged in broken crow order,

which will give four spots in each repeat of the weave. Fig. 3 (*a*) shows the design paper divided into sections after the manner previously explained. Small squares are also marked in certain sections, arranged in broken crow order, to indicate the positions of the spot figures. Fig. 3 (*b*)



(*a*) (*b*) (*c*) (*d*)

Fig. 3

shows the spot figure that is to be used, a small square in the center of the spot having been marked with a cross. It is intended that this square shall fall on the marked squares in Fig. 3 (*a*) when the spots are inserted in the design.

Fig. 3 (*c*) shows the spot inserted; two of the spots are twilled to the right and two to the left, for if all four of the spots were twilled in the same direction, two of the spots would necessarily run together, owing to their elongated shape. Fig. 3 (*d*) shows the completed design with the plain weave inserted as a ground weave.

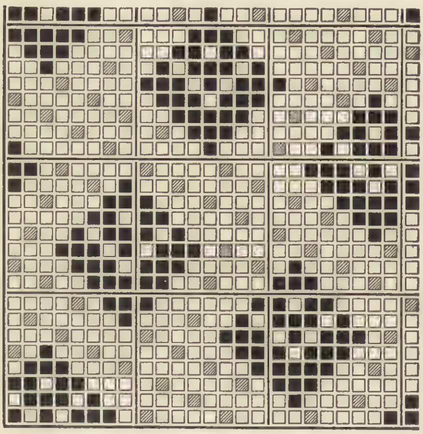


Fig. 4

6. Various weaves other than the plain weave may be used as ground weaves. Fig. 4 is given as an example of another type of ground weave. It is a spot weave on 25 ends and 25 picks, having the 5-end filling satin weave as a ground weave and with the spots arranged in 5-end satin order. In this design, wherever a riser of the ground would come in such a position as to interfere with the spot figure, that riser has been omitted. A plain ground could not be used in this design, because it would not match up well with every spot, and also because the weave repeats on an odd number of ends and picks.

FILLING-SPOT WEAVES

7. In constructing filling-spot weaves, the arrangement of the spots on the surface of the cloth is determined in exactly the same manner as described in connection with warp-spot weaves; in fact, the construction of a filling-spot weave very closely resembles that of a warp-spot weave with the single exception that in the former the filling floats on the surface of the cloth to form the spots, instead of the warp, as in the latter. To illustrate the construction of filling-spot weaves, suppose that it is desired to construct a spot weave

similar to that shown in Fig. 1 (*d*), with the exception that the spots are to be formed by the filling floating on the face of the cloth instead of the warp. In constructing this weave, wherever the spots are to appear on the cloth the warp must be depressed, so as to allow the spots to be formed by the filling floating, as shown in Fig. 5, and the spot is shown by blank squares instead of filled squares, as in the case of Fig. 1 (*d*), on this account. When inserting the ground weave in filling-spot designs, care should be taken to have the warp flushes of the ground weave oppose the filling flushes of the spot at every point so that the filling will not float over more ends than is desired to form the spots. In Fig. 5 the plain weave has been used as a ground weave and the risers of the ground weave completely encircle the filling flushes that form the spots.

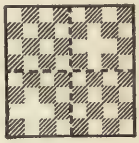


FIG. 5

As another illustration of the construction of spot weaves, suppose that it is desired to convert the warp-spot weave shown in Fig. 2 (*d*) into a filling-spot weave, retaining the same arrangement of the spots. Fig. 6 shows this weave complete, the spots being shown with blank squares, thus indicating that the warp is depressed and the filling raised, and therefore that the filling flushes form the spots on the face of the cloth. The plain weave has been used for a ground weave in this design, and the warp flushes of the ground weave oppose the filling flushes on all sides of the spots, as previously explained.

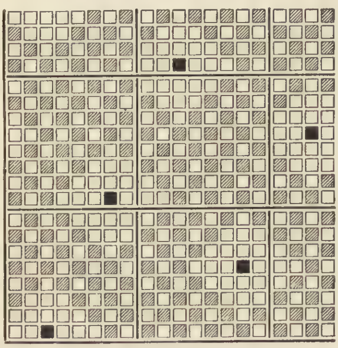


FIG. 6

8. Very neat effects may be formed in filling-spot weaves by using corkscrew or cord weaves as ground weaves, since both warp-corkscrew and warp-cord weaves show only warp on the face, or for that matter on the back of the cloth.

Filling spots may be made by allowing the filling to flush over a number of ends, and by having the warp of one color of yarn and the filling of another, a spot of a distinct color from the body of the cloth may be made; that is, the contrast between the color of the spot and the color of the ground is greater, because with warp corkscrews or cords as ground weaves the interlacings of the filling with the warp in the ground of the cloth do not show. Fig. 7 shows a weave constructed by this method in which a 7-end warp corkscrew has been used as a ground weave and the spots formed by flushing the filling on the surface of the cloth. In constructing weaves of this type, the best method of procedure is first to place the corkscrew or cord weave on the desired number of ends and picks, after which the spots may be made by erasing certain of the risers of the ground weave wherever it is desired to have a spot appear on the surface of the cloth. The number of risers that are erased will of course determine the extent of the individual spot. In constructing these weaves, it is very important that the warp flushes of corkscrew weave shall oppose the filling flushes on both sides of the spot. This has been done in Fig. 7; thus, considering the spot in the lower left-hand corner, on the eighth pick the third end is up and the fourth end down to form the spot, on the second end the filling that forms the spot flushes on the fifth, sixth, and seventh picks, while the warp flushes of the first end occur on these same picks. Again the filling flushes that

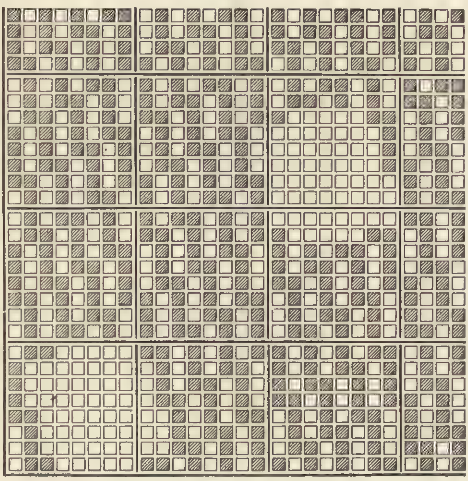


Fig. 7

form the spot cover the third end on the second, third, and fourth picks, while the second end is up on the same picks, etc. Warp-spot weaves may be made with corkscrew or cord weaves as ground weaves in a similar manner to filling-spot weaves. In this case, however, filling-corkscrew or filling-cord weaves are used as the ground weave and the spots produced by raising certain ends on as many picks as desired so as to form the spots.

EXAMPLES FOR PRACTICE

1. Make a warp-spot weave on 24 ends and 24 picks, using the plain weave as a ground weave and arranging the spot shown in Fig. 1 (*b*) in 8-end satin order.
2. Arrange the spot shown in Fig. 2 (*b*) in plain order on 18 ends and 18 picks and insert the plain weave as a ground weave.
3. Make an original warp-spot weave on 24 ends and 24 picks with the spot figures arranged in 6-end satin order.
4. Make a filling-spot weave on 28 ends and 28 picks, arranging the spots in plain order.
5. Arrange the spot shown in Fig. 3 (*b*) in plain order, twilling one spot to the right and the other to the left. Make the weave repeat on 16 ends and 16 picks and insert the plain weave as a ground weave.

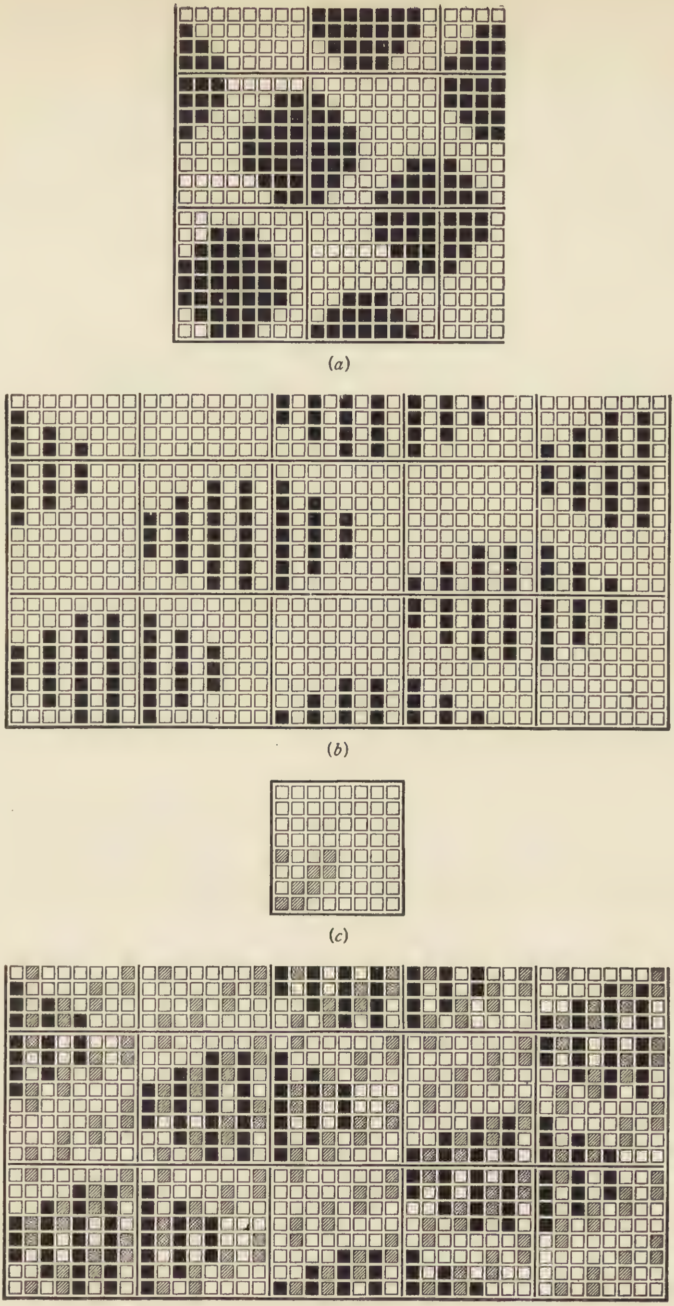
SPOT WEAVES FORMED WITH AN EXTRA SYSTEM OF YARN

SPOT EFFECTS WITH EXTRA WARP

9. In many fabrics of a spotted character, the ground is woven with one warp and one filling, and the spots, which are generally of a different color from the ground, are produced by the use of an extra, or figuring, warp or filling, or both. In these cloths, the ground, or body, of the fabric is produced in the ordinary manner, while the extra system of yarn, either warp or filling, that produces the spot figures is allowed to float at the back of the cloth except at those places where the spots occur, where it floats on the face in such a manner as to produce a spot of the required shape and size.

10. Suppose that it is desired to construct a spotted fabric with the spots produced by an extra system of warp

yarn. In producing a design of this character, the first step is to decide on the spot figure that is to be used, and the arrangement of the spots on the surface of the cloth. Fig. 8 (*a*) shows a spot figure arranged in 5-end satin order, which, for the purpose of illustration, will be converted into an extra-warp spot design. It is constructed after the manner of the spot weaves previously described, except that the ground weave is omitted. The first step in arranging this spot for extra warp is to separate the ends of the spot design, as shown in Fig. 8 (*a*), by blank ends, as shown in Fig. 8 (*b*). That is, in Fig. 8 (*b*) each end of Fig. 8 (*a*) is copied, but is placed on an odd-numbered end of Fig. 8 (*b*), the even-numbered ends being left blank for the reception of the ground weave. The completed weave for an extra-warp fabric of this type will require twice as many ends and the same number of picks as the spot arrangement; that is, Fig. 8 (*a*) occupies 20 ends and 20 picks, while Fig. 8 (*b*) occupies 40 ends and 20 picks. The next step is to insert the ground weave, which forms the body of the cloth; in this case, the cassimere twill, Fig. 8 (*c*), will be used. The ground weave is inserted on the ends of Fig. 8 (*b*) that were left blank, or, in this case, the even-numbered ends, as shown in Fig. 8 (*d*), which is the completed design. If this weave is warped 1 end of white and 1 end of green throughout the warp, and a solid-green filling used, it will be seen that white spots arranged as in Fig. 8 (*a*) will be produced on the surface of a solid-green twilled fabric. The extra, or white, warp floats on the face only to form the spot, and when not producing the spot is carried to the back of the fabric. The green, or body, warp, however, is interlaced with the filling as a cassimere twill to form the ground fabric on which the white spots are arranged. Since the extra, or figuring, warp interlaces so infrequently with the filling, it takes no part in forming the structure, or body, of the cloth; the ground ends, being crowded together by the interlacing of the filling, throw the extra-warp ends up on the face to form the spot when these ends are raised and force them to the back when they are depressed. Care



(a)

(b)

(c)

(d)

Fig. 8

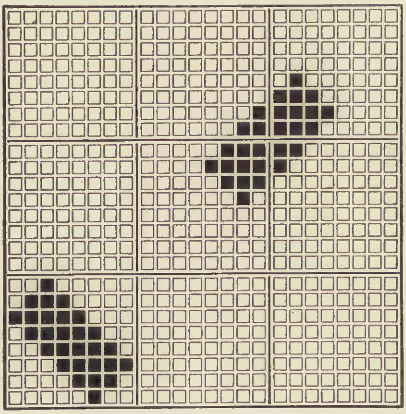
must be taken in selecting a ground weave for these fabrics to select a weave that will repeat evenly on the number of ends and picks that is occupied by the spot arrangement; that is, it must repeat evenly on the same number of picks and one-half the number of ends that the completed weave occupies.

11. Tying.—It frequently happens in the case of very thin fabrics that the extra warp when carried to the back of the fabric will show through on the face, especially if the ground cloth is of a light color and the figuring warp dark, or vice versa. When this is the case, the loose floats of the extra warp must be cut from the back of the fabric, but if this is done, the weave must be arranged so that the spots will be firmly bound to the cloth. In the case of Fig. 8 (*d*), if the floats of the extra warp on the back of the cloth were cut off close, there would be nothing to attach the face floats of extra warp to the cloth, since the extra warp is only passed from the face to the back without other interlacing with the filling. Therefore, such a fabric would not be serviceable, since the spots would easily rub and wear off. To remedy this fault, it is customary, when the figuring warp is to be cut from the back of the cloth, to bind each float of the extra warp on the face by passing it under 1 pick and over 1 pick of the ground before passing it finally to the back of the cloth. This extra binding at the edge of the spots prevents the floats of the extra warp on the face from being too easily rubbed off after the floats at the back of the cloth have been cut and removed.

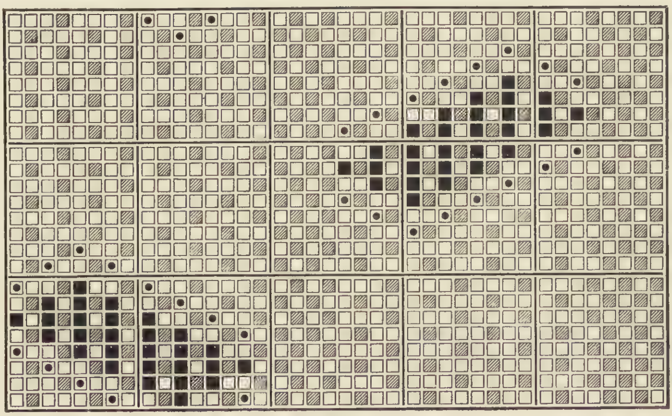
Fig. 9 (*a*) shows an arrangement of spot figures in plain order, while Fig. 9 (*b*) shows these spots arranged as an extra-warp design with each face float of the extra warp bound to the cloth by passing it under and over the filling before finally allowing it to float on the back of the fabric. The ground weave in this case is the plain weave.

In some cases it is not desired to cut the extra-warp floats from the back of the cloth, and yet the spots are so far apart on the face that the floats on the back are so long as to be very loose. When this is the case, the extra warp is usually

tied to the ground cloth by being raised over a single pick of the ground weave at a point approximately half way between the spots, that is, in the center of the float on the back, or perhaps the float may be tied twice or even oftener between



(a)



(b)

FIG. 9

the spots. In arranging these tying places, care should be taken to bring the extra warp up on a pick that has a ground-warp end on each side also raised over it. These floats of the ground ends will then crowd together and completely

hide the tying place of the extra warp. To illustrate this point, Fig. 10 (*a*) shows an elliptical spot arranged in plain order, while Fig. 10 (*b*) shows the same design arranged for extra warp, with the extra warp tied into the cloth. Particular attention should be paid to the position of the tying

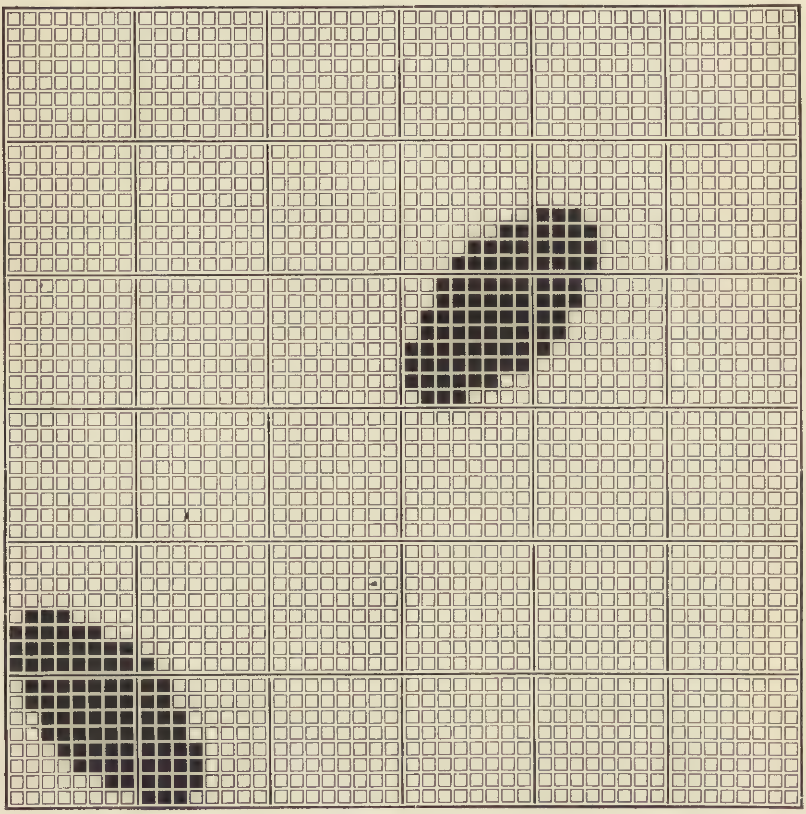


Fig. 10 (*a*)

places, since the extra warp is raised in each instance between two warp floats of the ground weave and as near the center of the extra-warp float on the back of the cloth as is consistent with the attainment of proper binding places for concealing the extra-warp end.

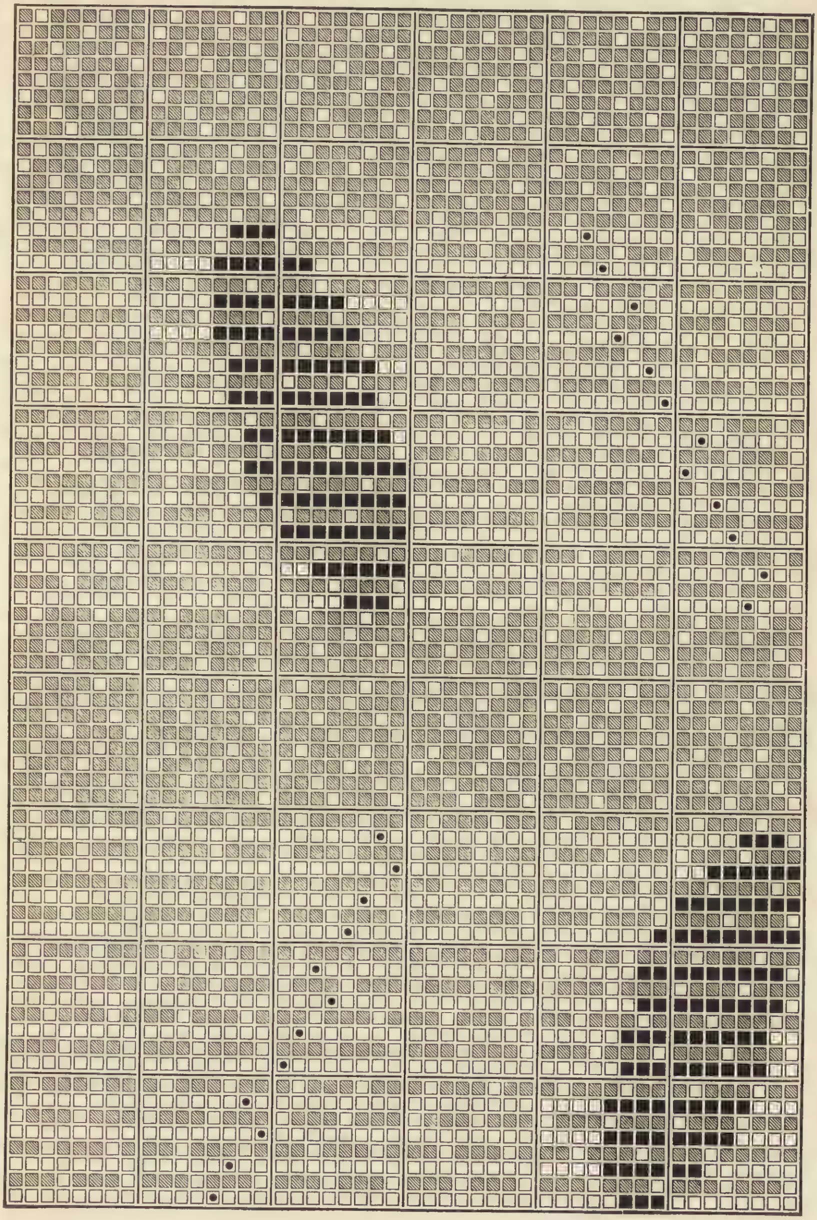


FIG. 10 (*b*)

12. Stripe Spot Effects.—When it is desired to separate the spots so that they will appear on the surface of the cloth a greater distance apart, as many ends of the ground weave as are desired may be inserted between the spots. Spots are often arranged one above the other in the direction of the warp and a large number of ground ends inserted between them, thus forming a cloth having a **spot stripe** running through it. Fig. 11 shows a design of this description, a simple round spot being arranged so that as the design repeats in the cloth, the spots will be repeated one over the other throughout the length of the cloth. The ground weave is the 4-harness basket and is repeated so that the spotted stripes down the length of the cloth will be separated by 43 ends of the ground. This separation of the stripes can of course be increased or diminished to suit any requirements, by simply inserting the required number of repeats of the ground weave. If this weave were woven with a warp

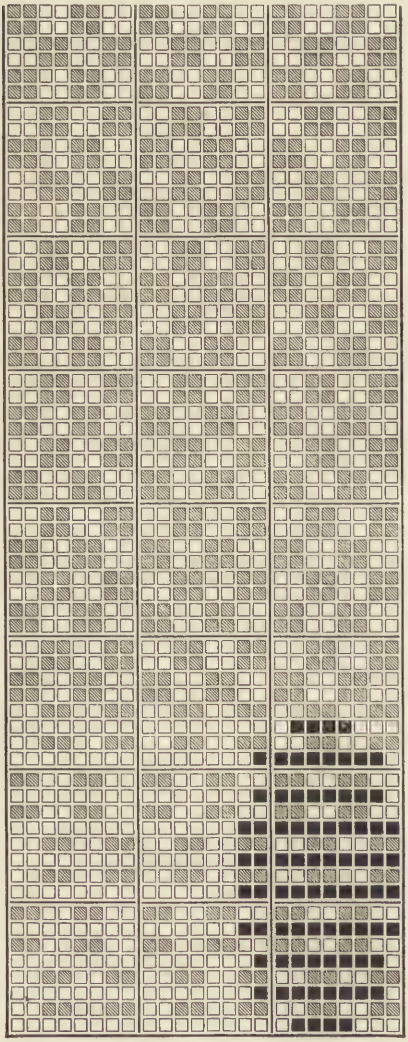


Fig. 11

arranged 1 end of black and 1 end of red for 20 ends and then 42 ends of red, and a solid-red filling used, a stripe of black spots would be formed on a red ground.

Stripe spot effects are often arranged so that spots of two or more different colors are formed, often alternately one above the other. When this is the case, 2 extra-warp ends must be inserted together between the ground ends; that is, if two differently colored spots are to be formed. Fig. 12 shows a design arranged in this manner. If the warp were arranged 1 black, 1 white, 1 red, for 18 ends, 1 black, 1 white, 80 red, and woven with red filling, a red fabric would be formed with a stripe composed of alternate spots of black and white. The lower spot in Fig. 12 would form a black spot and the upper one a white spot.

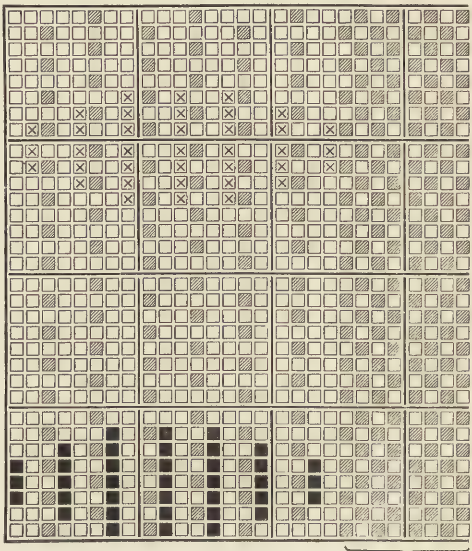
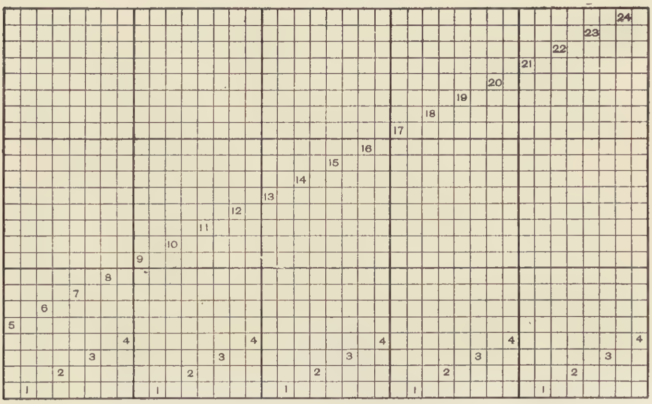


FIG. 12

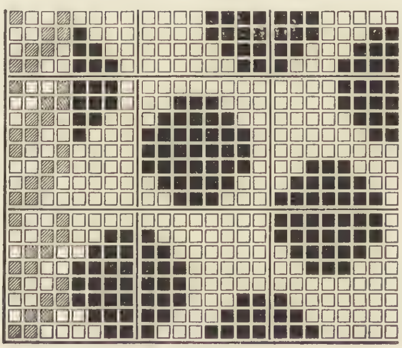
10×

13. Harness and Chain Drafts. In making harness, or drawing-in, and chain drafts for extra-warp fabrics, it is advisable to separate the harnesses carrying the ground ends from those carrying the extra-warp ends, since fabrics of this description require two beams, owing to the difference in take-up between the ground warp and the extra, or figuring, warp. It is customary to draw the ground ends on the front harnesses and the extra-warp ends on the back harnesses, although this is a matter of very little importance. The design could just as well be woven with the extra warp

drawn on the front harnesses as with the ground warp drawn on the front harnesses, but the latter is a little more convenient, since the ground warp in many cases contains a greater number of ends than the figuring warp; consequently there is a greater liability of the ground ends breaking, and



(*a*)



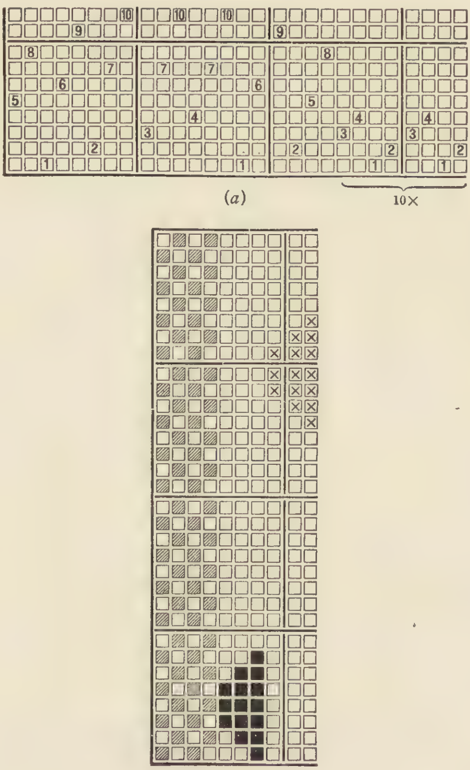
(*b*)

FIG. 13

if drawn on the front harnesses, it is very much easier to tie ends in when they break in the loom. Fig. 13 (*a*) shows the drawing-in draft for the design shown in Fig. 8 (*d*), while Fig. 13 (*b*) shows the corresponding chain draft. From a careful study of these drafts, their method of construction

will be readily apparent and no further explanation will be necessary.

As another illustration, however, using a somewhat different case, Fig. 14 (*a*) and (*b*) is given. Fig. 14 (*a*) is the drawing-in draft, and Fig. 14 (*b*) the chain draft for Fig. 12. There are two distinct systems of extra warp; the ground



(*a*) 10×

(*b*)

FIG. 14

ends have been drawn on the first 4 harnesses, the black extra warp on the second set of 3 harnesses, that is, on the fifth, sixth, and seventh harnesses, and the white extra warp on the eighth, ninth, and tenth harnesses. By separating the warp into three systems in this manner, the first

4 harnesses will carry red ends only, while the fifth, sixth, and seventh will carry only black ends, and the eighth, ninth, and tenth only white. This makes it much easier for the weaver when tying in broken ends than would be the case if the black and the red extra-warp ends were drawn in on alternate harnesses, as they appear in the design; that is, this design could be drawn in so that the first 4 harnesses would contain the ground ends; the fifth harness, black extra-warp; the sixth harness, white extra-warp; the seventh harness, black extra-warp; the eighth, white extra-warp; the ninth, black extra-warp; and the tenth, white extra-warp. If this method were used, there would be some liability of the weaver drawing the extra-warp ends through the wrong harnesses when tying in broken ends. A careful comparison of Fig. 14 (*a*) and (*b*) and Fig. 12 will show distinctly the method of constructing the harness and chain drafts.

EXAMPLES FOR PRACTICE

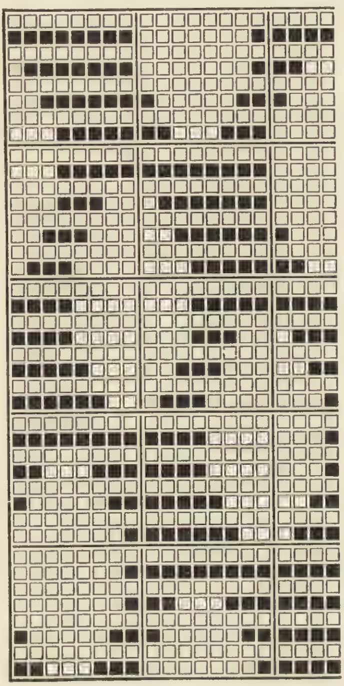
1. Arrange Fig. 3 (*c*) as an extra-warp spot design, using the plain weave as a ground weave.
2. Show harness and chain drafts for the design made in answer to example 1, showing the ground ends drawn on the 4 front harnesses.
3. Arrange Fig. 2 (*c*) as an extra-warp spot design, using the 4-harness cassimere twill for a ground weave.
4. Show harness and chain drafts for the design made in answer to example 3.
5. Show harness and chain drafts for Fig. 11, drawing the ground weave on 4 harnesses.

SPOTS FORMED BY EXTRA FILLING

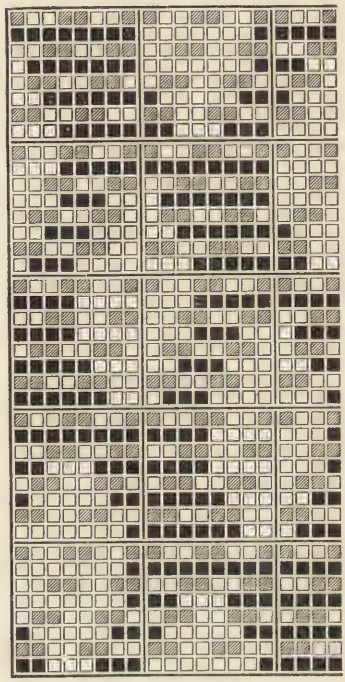
14. Cloths in which the spot is formed on the surface by an extra, or figuring, series of filling yarn are constructed very similar to extra-warp fabrics, except that the spots are produced by filling yarn instead of warp yarn. The structure of the fabric may be said to be practically the same; that is, the cloth consists of a ground, or body, woven with a simple weave, and spots produced by flushes of extra filling on the face at certain points, while when the figuring filling is not to be used to form a spot, it floats on the back of the

cloth. In constructing fabrics of this kind, place the spot figures on the design paper, alternating each pick with a blank pick, on which the ground weave may afterwards be inserted.

After deciding on a certain spot and arrangement of spots, the spots must be so placed on the design that the filling will flush on the face at those points where it is desired to have



(a)



(b)

FIG. 15

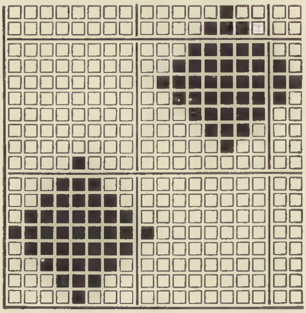
the spots appear. For instance, suppose that it is desired to arrange Fig. 8 (*a*) for an extra-filling design. Separate the picks and place them on design paper, as shown in Fig. 15 (*a*); wherever it is desired to have the spot appear, the filling is allowed to flush on the face, and at every other place the entire warp is raised over the pick of filling so that it will float on the back of the cloth. Fig. 15 (*a*) represents the

exact reverse of Fig. 8 (*a*), with the exception, of course, that Fig. 15 (*a*) is opened out, the picks being separated by blank picks. To complete the design it is now only necessary to insert the ground weave on the blank picks that are left for its reception. The completed design is shown in Fig. 15 (*b*), in which the 4-harness, or cassimere, twill has been inserted as a ground weave. While with extra-warp fabrics twice as many ends as picks were required, in extra-filling fabrics twice as many picks as ends are required, that is, if the spots are not separated by several picks of ground.

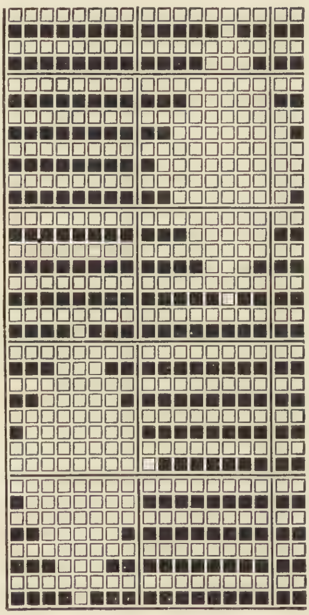
15. To illustrate further the method of forming designs of this type, suppose that it is desired to arrange the spot shown in Fig. 16 (*a*) as an extra-filling design. Fig. 16 (*b*) shows this spot arrangement placed on the design paper occupying 18 ends and 36 picks; that is, Fig. 16 (*b*) occupies the same number of ends and twice as many picks as Fig. 16 (*a*). Inserting a plain ground weave, as shown in Fig. 16 (*c*), completes the design, which will produce a spot arranged in plain order. If either Fig. 15 (*b*) or Fig. 16 (*c*) is woven with a solid-red warp, and picked 1 white and 1 red, white spots will be produced on a red fabric, and in the case of Fig. 15 (*b*), the arrangement, shape, and size of the spots will be exactly the same as in Fig. 8 (*d*), except that the spots in Fig. 15 (*b*) will be formed with an extra-filling yarn, while in Fig. 8 (*d*) they are formed with extra-warp yarn.

16. Tying.—In cases where the extra-filling yarn is to be cut from the back of the cloth, each float of extra filling on the face of the cloth may be bound in a manner similar to that explained in connection with extra-warp fabrics. This is accomplished by allowing the filling to be depressed under 1 end and float over 1 end at each end of each filling float on the face, thus tying the fabric in the same manner as the extra warp was tied. Also, if the floats of filling on the back of the cloth are not cut off and are very long, it is well to tie the extra filling to the body of the cloth. This may be accomplished by raising the pick of filling over a single end at a point somewhere near the middle of the float on

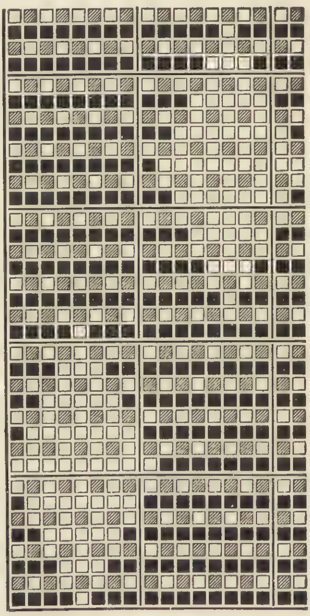
the back, arranging this tying place so that the extra filling will be raised over an end between two picks of the ground filling that are raised over the same end. These two filling



(a)



(b)



(c)

FIG. 16

flushes of the ground will cover the tying place so that it cannot be seen on the face of the cloth.

17. In arranging the harness and chain drafts for extra-filling fabrics, no difficulty should be experienced, since the fabrics are woven with a single system of warp and drawn in exactly like a simple fabric, usually being arranged as a straight draft.

EXAMPLES FOR PRACTICE

1. Arrange Fig. 3 (*c*) as an extra-filling design, using the plain weave for the ground.

2. Arrange Fig. 9 (*a*) as an extra-filling design, using the cassimere twill for the ground weave.

3. Arrange Fig. 10 (*a*) as an extra-filling design, using the 4-harness basket weave for the ground.

4. Make an original spot figure and arrange it in 6-end satin order as an extra-filling design to be complete on 30 ends and 60 picks.

5. Show harness draft for the design made in answer to example 3.

WEAVES FOR BACKED COTTON FABRICS

FILLING-BACKED CLOTHS

1. In many cloths, an extra system of warp or filling is adopted for the purpose of adding weight, bulk, or warmth, in which case the extra yarns are bound to the cloth at regular intervals in such a manner that they do not show at all on the face. Cloths of this description are known as **backed fabrics.** The manufacture of backed cloths is often resorted to for the purpose of making a heavy and yet cheap fabric, since by using a cheaper extra warp or filling a thicker and more substantial cloth can be obtained at a low cost, while at the same time the necessary thickness and weight may be obtained without altering the fineness of the face of the fabric or without changing its appearance.

2. Under the head of backed fabrics are found two subdivisions; namely, cloths backed with *filling* and cloths backed with *warp*. A **filling-backed fabric** may be considered as a single cloth consisting of one warp and one filling, but having bound, or tied, to the back an extra set of filling threads, which are interlaced with the face cloth just enough to keep them attached and prevent the floats on the back of the cloth from being so long that they will be loose. This effect is obtained by raising the warp yarn in such a manner that when the face, or regular, filling is inserted it will interlace with the warp and form the pattern desired.

When, however, the pick of backing filling is placed in the cloth, all the warp ends are raised with the exception of a few that are left down, in order to bind the backing filling to the face cloth. This has the effect of making the picks of backing filling float on the back of the cloth, except where they pass over the few ends that accomplish the *binding*, *tying*, or *stitching*, as it is sometimes called.

The filling in filling-backed fabrics may be arranged 1 pick of face and 1 pick of back, 2 picks of face and 1 pick of back, or 2 picks of face and 2 picks of back. All filling-backed fabrics, since they are composed of two different fillings, require a box loom for their production, unless the same yarn is used for the backing filling as for the face, which is not usually the case. In case the cloth is woven in a loom that has but one box on one of its sides, the filling must be inserted 2 picks of face and 2 picks of back, since in this type of loom it is not possible to put in a single pick of one kind of filling, as the shuttles must always return to the box side before changing. Fabrics in which a single pick of the backing filling is inserted at a time require a loom with more than one box at each side, in which it is possible to change the filling at either side of the loom and consequently on any pick. When, as is often the case, coarser yarns are used for the back than for the face filling, the fabric is often woven with 1 pick of backing and 2 picks of face, and sometimes in extreme cases, 3 or even 4 face picks are used to 1 pick of backing.

Weaves for filling-backed cloths woven with face and backing filling in the proportions given are not always arranged in exactly the order stated. For instance, the weave for a cloth woven with 2 picks of face alternating with 1 pick of backing may be arranged 1 face, 1 back, 1 face. This, of course, makes no actual difference in the cloth and is simply mentioned so that if a weave is noticed in which the first pick is a face pick and the next pick a backing pick, it will not be thought that the weave is necessarily arranged 1 face and 1 back, since the next 2 picks may be face picks, and so on.

3. When binding the backing filling to a filling-backed cloth, the tying places should be so arranged that the backing picks will be over the face-warp ends between two floats of the face filling. The object of this is to cover the tying places so that they cannot be seen on the face of the cloth, the two floats of the face filling, one float on each side of the backing filling, crowding over the backing pick where it passes over the warp and thus hiding it from view.

In addition to so tying the backing filling that it will not show on the face of the cloth, the tying places should be placed uniformly throughout the fabric so that the cloth will not cockle. The best method of distributing the tying places is in satin order, since by this method not only are they evenly distributed, but all liability of the binding places forming twill lines on the face of the cloth is obviated. Although the method of distributing the tying places in satin order is the most satisfactory, because of the scattered yet uniform disposition of the interlacings of the back filling with the face warp, it often happens that the character of the face weave is such that the tying places cannot be distributed in this manner and at the same time each be located between two flushes of the face filling. When such is the case it is always better to adopt some other system of binding, such as twill, broken crow, etc., rather than run the risk of having the backing yarn show on the face of the goods. With filling-backed fabrics, it is impossible to form any fancy effects on the back of the fabric, and, in fact, this is not desired, since the main object is to obtain a heavy- or medium-weight fabric with a fine face produced with yarns of fairly high counts.

4. When making designs for filling-backed fabrics, the first step is to indicate the face and back picks on the design paper, in order that they may not be mistaken and the weave placed on the wrong pick. This may be accomplished by placing a small mark at one side of the design opposite each backing pick or, preferably, by shading the backing picks with a colored pencil. If the design is to be composed of

1 pick of face alternating with 1 pick of back it is better to start at the bottom of the design and make the first pick a face pick. The second pick should be made a back pick, by shading, and so on until the required number of picks have been treated in this manner.

5. Suppose that it is desired to back the 8-harness twilled basket weave shown in Fig. 1 with filling, in order to obtain a heavier fabric, the filling to be inserted 1 pick back, 2 picks face. This will give 4 picks of back and 8 picks of face, or 12 picks altogether, in 1 repeat of the design. When making a filling-backed design of any description, care must be taken to have both the back and face weaves evenly repeated on the back and face picks, respectively. The method of backing must also be considered when determining the size of the completed design. The first operation is to indicate the backing picks, which may be done by shading them, as shown in Fig. 2. The face weave, Fig. 1, is then placed on the face picks in Fig. 2, as indicated in Fig. 3, the backing picks still remaining unmarked.

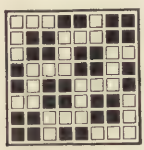


Fig. 1

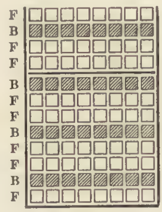


Fig. 2

The next step in the formation of the design is to raise all the warp on the backing picks, except such threads as are required to be left down for the purpose of binding the backing filling to the body of the cloth. The method of doing this is shown in Fig. 4, the squares marked with crosses indicating where the warp is raised over the backing picks. By referring to this design, it will be noticed that the tying points are distributed in twill order, as this is the best method by which the filling can be bound with this weave, it being obviously impossible to use satin order of tying without repeating the design,

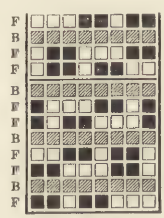


Fig. 3

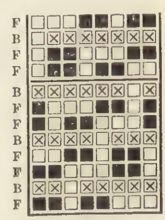


Fig. 4

since there are only 4 picks of backing filling. It will be noticed that the binding places, where the backing filling comes to the face of the cloth, are placed on ends over which the face filling passes on the preceding and succeeding pick, thus hiding the pick of backing filling. Thus, for example, on the first and third picks, which are face picks, the filling passes over the same end as does the backing filling on the second pick. This method of raising the picks of backing filling occurs throughout the weave. Each pick of backing filling in this design is tied to the face only once in 8 ends, but it would be possible with this design to bind the backing filling twice in 8 ends, if it were desired to produce a firmer piece of goods.

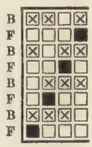


FIG. 5

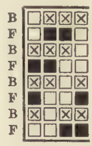


FIG. 6

6. Fig. 5 shows a filling-backed design arranged 1 face and 1 back. In this design, every end of the warp serves at one time in each repeat of the weave to bind the backing filling to the face. Tying on every end of the warp in filling-backed fabrics makes the most perfect cloth, since all the ends will then take up the same and there will be no liability of the cloth wrinkling. However, this is not always done, especially when a soft cloth is desired. Very often every other end of the warp serves to tie the backing filling, as is the case in Fig. 4. It is not best, however, to tie on every other warp end if a very thick or coarse backing yarn is to be used, since this will surely make a faulty cloth unless two warp beams are used, which is rarely done with a filling backed fabric. When designing filling-backed cloths, it is always best to use soft-twisted yarn for the backing; hard-twisted or too coarse backing yarn is more or less liable to show on the face of the cloth, especially if fine yarns are used for the face weave.

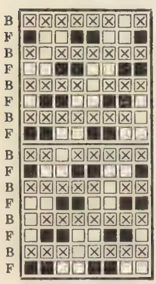


FIG. 7

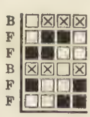


FIG. 8

The cassimere twill $\frac{2}{2}$ is a weave that is often required to be backed with filling, and in Figs. 6, 7, 8, and 9, four standard methods of accomplishing this are shown. The designs in Figs. 6 and 7 are to be preferred, as the backing filling is tied an equal number of times on each end of the warp. Figs. 8 and 9, while not tied perfectly, may be successfully used in cases where the backing filling is not too coarse.

7. In constructing weaves for filling-backed cloths, the best relation of the face weave to the back weave should always be determined. For instance, suppose that a face weave is placed on design paper as shown in Fig. 10. In this case, there is no place where the backing pick can be raised for tying without having the face warp up on one side of the

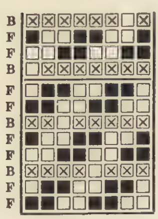


FIG. 9

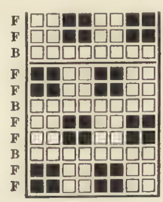


FIG. 10

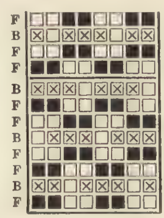


FIG. 11

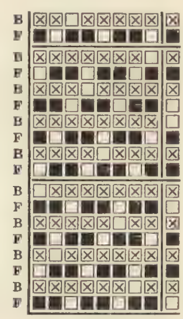


FIG. 12

tying point, which is liable to cause the binding to show on the face of the goods. If, however, the face weave is placed on the design paper as shown in Fig. 11, the backing can readily be tied to the face without any danger of its showing. The backing weave in this design is the broken crow weave.

Weaves that have a large percentage of warp on the face, especially warp-flush twills, are the hardest to back with filling, on account of there not being places in the weave where the tying places may be perfectly covered. When such weaves are backed with filling and it is impossible to have a face-filling flush on each side of the tying place, the design should be so arranged that the flush of face filling next to the tying place shall follow rather than precede the flush of backing filling. When the face flush precedes the

backing flush, the tie will show prominently on the face of the goods; but when the face flush follows the backing flush, the reed, in beating up the filling, will push the face pick over the backing pick. This method is employed in the weave shown in Fig. 12, where the warp-flush prunelle twill has been backed with filling, the backing weave being the 9-end satin weave.

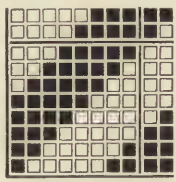


FIG. 13

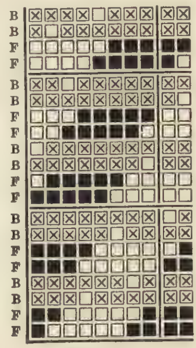


FIG. 14

8. In Fig. 13 a 10-harness regular twill $\frac{5}{5}$ is shown, while in Fig. 14 the same twill is shown backed with filling arranged 2 face and 2 back. Particular notice should be taken of the arrangement of the tying places in this design, as well as those in Fig. 15, which represents two repeats of the same twill backed with filling and arranged 2 face and 1 back. In Fig. 15, the backing filling is tied on every other end by two lines of twills, thus tying on all the ends in the warp.

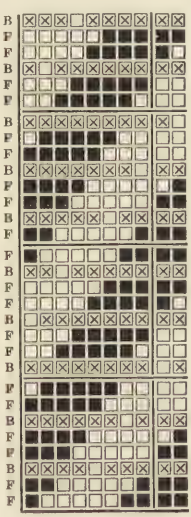


FIG. 15

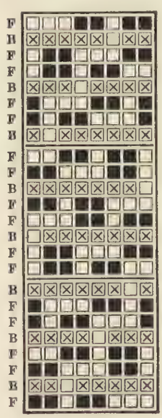


FIG. 16

In order to obtain a good system of tying, it is often necessary to repeat a design. Thus, for instance, if it was desired to use heavy or coarse backing filling in the design shown in Fig. 4, it would be necessary, in order to tie on every end to either bind the filling once in every 4 warp ends or repeat the design and bind as shown in Fig. 16, which shows Fig. 4 repeated in its picks.

When tying a backing filling to a face cloth that has long filling floats, the tying places should always be as near the center of these floats as possible, since, when tied in this manner, the binding points will be more easily covered.

EXAMPLES FOR PRACTICE

1. Make a filling-backed weave arranged 1 face, 1 back, using the $\frac{4}{4}$ regular twill for the face; tie the backing filling perfectly once on each warp end.

2. Make an 8-end filling satin and back it with filling, arranging it 1 face and 1 back.

3. Back the cassimere twill with filling, the weave to be arranged 1 face and 1 back and capable of being woven on 4 harnesses.

4. If a 12-harness regular twill is backed with filling, the weave being arranged 1 face, 1 back, 1 face, on how many ends and picks will the weave be complete?

5. Back the regular twill $\frac{2}{2}\frac{2}{2}\frac{1}{1}$ with filling, arranging the weave 1 face and 1 back. Tie each backing pick once in 10 warp ends.

6. Back the $\frac{3}{1}$ twill, twilled to the left, with the 8-end satin, arranging the weave 1 face and 1 back; have the face-filling flush follow rather than precede the back-filling flush.

WARP-BACKED CLOTHS

9. Warp-backed fabrics are those cloths constructed with one system of filling and one system of warp yarns for forming the face of the goods and also an extra system of warp yarn for making a heavier and warmer fabric than would be possible with a single cloth. These cloths require more harnesses than filling-backed cloths, on account of the extra, or backing, warp, while on the other hand they can be woven in looms with single boxes, since there is only one system of filling to be placed in the cloth. This is a great advantage in those cases where single-box looms are all that can be used. This of course applies only to cloths in which one kind or color of face filling is used, since if more than one kind is used a box loom will be necessary.

It requires only the same amount of time to weave warp-backed fabrics that would be occupied in weaving any cloth with the same number of picks per inch, since there are no extra picks of backing filling to be placed in them. Color can also be applied to the back of warp-backed fabrics to advantage, since stripe effects can be easily made, while with filling-backed cloths only bars across the cloth can be made, which is rarely a satisfactory method of applying color. However, care should be taken in all cases where a different color from that of the face yarn is applied to backed cloths, to have the binding points perfect, so that the color of the backing yarn will not show on the face of the goods.

In weaving the majority of cloths backed with warp two beams are required, since the backing warp is generally of a coarser yarn and has different interlacings with the filling than has the face warp, thus causing a different amount of contraction. It is necessary that the backing yarn in a warp-backed fabric should be harder-twisted than the backing yarn in a filling-backed fabric, since it has to withstand the strain that comes on all warp yarn during weaving. On this account warp-backed fabrics will feel harsher and stiffer than filling-backed fabrics, in which soft-twisted yarns are almost exclusively used for the backing filling.

10. There are several important points that should be noted when considering warp-backed fabrics. (1) The backing-warp must be raised over a pick in every instance where it is desired to bind the backing warp to the face cloth; this, it will be seen, is the reverse of the case with filling-backed fabrics, where a warp end is depressed, in order to bind the cloth. (2) In warp-backed fabrics, the tying places should always be placed between two warp flushes of the face cloth, in order that the tying may be covered and not show on the face of the cloth; if in any case this is impossible, the backing warp may be raised either to the right or left of a face-warp flush. (3) If there are more interlacings of the face warp with the filling than there are of the back warp with the filling in a given number of

picks, or if one series of warp yarn is coarser than the other, it will be necessary to place the two warps on separate beams, since the take-up of the warps in weaving will be different. (4) It is always best to select weaves of regular structure, such as satins, broken crow, etc., for the backing weave, so that each backing end will have the same number of interlacings. (5) If a warp-backed fabric is arranged 1 face and 1 back, the backing warp should never be of heavier yarn than the face, since if this is the case the back will show through on the face of the cloth. (6) If the design is arranged 2 face and 1 back, a proportionately heavier yarn can be used for the back warp.

11. Suppose that it is desired to back the cassimere twill with warp, using the 8-harness satin weave for binding the backing warp to the cloth, the design to be arranged 1 face end and 1 back. As the back weave in this case will require 8 ends, it will be necessary to show two repeats of the face weave in the complete design, the cloth being woven 1 and 1. Therefore, the finished design will be complete on 16 ends and 8 picks. The first operation is to shade or in some other manner to indicate the backing ends, in order that

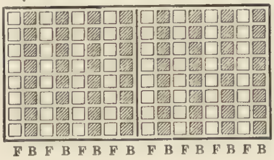


Fig. 17

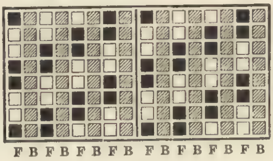


Fig. 18

they may be distinguished from the face ends. The method of doing this is shown in Fig. 17, where the vertical rows of squares for the backing weave are shaded, while those for the face weave are left blank. Fig. 18 shows the cassimere weave, which is to be used for the face weave in this design, placed on the face ends. The next step is to place the backing weave on the design. As the back weave, which is to be the 8-end satin, must flush on the back of the cloth, each back-warp end should be raised only once in 8 picks and in

satin order. The method of placing the back weave on the design paper is shown in Fig. 19, where the design is shown complete, crosses indicating where the backing warp is raised. In this figure, the method of raising the back warp at the

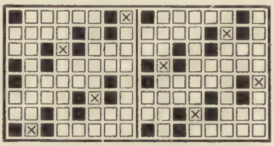

F B F B F B F B F B F B F B F B

Fig. 19

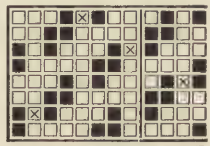

F B F F B F F B F F B F

Fig. 20

tying places between two face-warp flushes should be carefully noted, the object of course being to allow the floats of face warp to crowd over and hide the tie.

12. Fig. 20 is another design showing the cassimere twill backed with warp. In this case, however, the ends are arranged 2 face and 1 back and the back warp is bound in left twill order. Fig. 21 shows still another method of back-

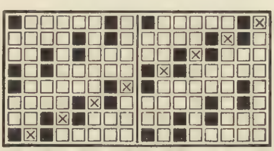

F B F B F B F B F B F B F B F B

Fig. 21

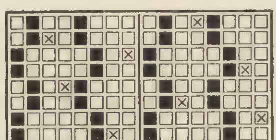

F F B B F F B B F F B B F F B B

Fig. 22

ing the cassimere twill with warp, each backing warp end being tied once in 8 picks and the ends arranged 1 face and 1 back. Fig. 22 is a design for a basket weave backed with the 8-end satin weave, the ends being arranged 2 face and 2 back.

HARNESS AND CHAIN DRAFTS

13. Ordinarily, with filling-backed fabrics, only as many harnesses are required to weave the design as are required for the face weave alone. In the case of warp-backed fabrics, however, as the backing warp always interlaces with the filling differently from the face warp, it must be drawn in

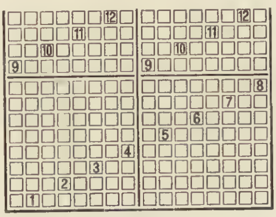
on separate harnesses. A warp-backed weave may be drawn in exactly as a single cloth if it is so desired. In this case, if the weave is arranged 1 face and 1 back, the first harness will be used for the face warp, the second harness will have the backing warp, and so on, each alternate harness being used for the backing harness. This method of drafting is adopted in some instances in connection with warp-backed fabrics of simple design, but in the majority of cases it is desirable to separate the harnesses for the backing warp from those through which the face warp is drawn, since it makes the harness draft much simpler for the weaver, thus rendering the liability of broken back-warp ends being tied in on harnesses through which face ends should be drawn, or vice versa, less probable.

There are two methods of separating the harnesses carrying the backing warp from those carrying the face, the first being that of drawing in the back warp on the back harnesses and the second being that of drawing the back warp through the front harnesses. Both methods are largely in use, but for certain reasons the latter is to be preferred. By drawing the backing ends through the front harnesses they are more readily accessible to the weaver, and as the backing ends are frequently of poorer material and thus break oftener, this is somewhat of an advantage. For the same reason, namely, that the backing ends are often weaker than the face ends, it is also an advantage to place the backing warp on the front harnesses, since the back harnesses are lifted higher during weaving, thus bringing more strain on the yarn drawn through them.

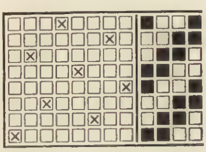
14. The method of making the drafts for a warp-backed fabric will be explained, taking Fig. 19 as an example. The first step is to make the harness draft. In drafting this design, the back warp will be placed on the front harnesses and consequently will be drafted first. Since in this example the backing weave is an 8-harness satin, it will require 8 harnesses. Proceed exactly as in single cloth, taking care, however, as this weave is arranged 1 face and 1 back, to

leave every other vertical row of squares on the design paper for drawing in the face warp. Next make the harness draft for the face weave, placing it above the draft for the back weave but on the vertical rows of squares reserved for the face warp. As the face of Fig. 19 is a 4-harness weave, there will be two repeats of the face drawing-in draft to one repeat of the back. The complete drawing-in draft obtained as explained above is shown in Fig. 23 (*a*), the back warp being drawn in on the front harnesses.

In making the chain draft, the same system as that explained in connection with single cloths is adopted; and

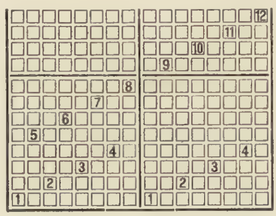


(*a*)

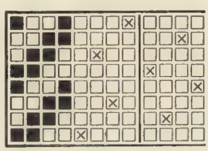


(*b*)

Fig. 23



(*a*)



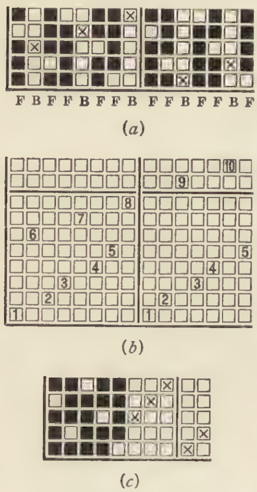
(*b*)

Fig. 24

since the warps have been separated and drawn in on separate harnesses, the face and back weaves will be separated in the chain draft. Fig. 23 (*b*) shows the chain draft for Fig. 19 drawn in according to the harness draft shown in Fig. 23 (*a*); the crosses show the picks on which the back-warp harnesses are raised.

If it were desired to draft Fig. 19 with the back warp drawn in on the back set of harnesses, the harness draft would be made as shown in Fig. 24 (*a*). When making the chain draft for Fig. 19 according to the harness draft shown in Fig. 24 (*a*), the same method is observed as with single cloth, which gives the draft shown in Fig. 24 (*b*).

15. When drafting warp-backed weaves that are arranged 2 face and 1 back, the same methods are employed as those previously explained except that 2 face ends are placed consecutively on the drawing-in draft in accordance with the design. The method of making this style of drawing-in draft is shown in Fig. 25 (*b*), which is the drawing-in draft for Fig. 25 (*a*). The chain draft for Fig. 25 (*a*) according to the drawing-in draft shown in Fig. 25 (*b*) is shown in Fig. 25 (*c*).



(*a*) (*b*) (*c*)

Fig. 25

EXAMPLES FOR PRACTICE

1. Back the $\frac{4}{2}$ regular twill with warp, arranging the ends 1 face and 1 back; tie each backing end perfectly.

2. Back the $\frac{4}{2}\frac{3}{3}$ regular twill with warp, arranging the ends 1 face and 1 back; tie the backing warp in 12-end satin order.

3. Make a design for a warp-backed fabric having the $\frac{3}{1}$ regular twill on the face and the 8-harness satin weave on the back, arranging the ends 1 face and 1 back; show harness and chain drafts with the back warp drawn in on the front harnesses.

4. Back the $\frac{4}{1}$ regular twill with warp, arranging the ends 1 face, 1 back, 1 face; tie the backing warp in 5-end satin order and show harness and chain drafts with the face warp drawn in on the front harnesses.

PIQUES AND BEDFORD CORDS

PIQUÉS

16. Although **piqués** cannot strictly be classed with either filling-backed or warp-backed cloths, they have features similar in many respects to both types. For example, a piqué cloth has a separate system of filling, known as the **wadding filling,** and in this respect resembles a filling-backed fabric. It also has a separate system of warp ends, in which respect it resembles warp-backed fabrics; but unlike warp-backed fabrics these backing ends in piqués are for the purpose of holding the wadding filling and also to cause ridges across the cloth, not to add any weight or warmth to the fabric.

In making a design for a piqué, the following points should be noted: (1) When placing the weave on design paper, the first step is to indicate the vertical rows of squares on which the face ends are to be placed and also the vertical rows of squares on which the backing ends are to be placed; this can be done by shading the vertical rows of squares representing the backing ends, as was done when making warp-backed designs. (2) The proportion of face ends to back ends in piqués is generally 2 face and 1 back; that is, every third end on the design paper will be a backing end. (3) The picks on which the wadding filling is to be inserted should be indicated in some way. (4) The proportion of face picks to wadding picks depends to a large extent on the kind of yarn to be used for the wadding; in case it is coarser than the yarn for the face picks, the proportion is generally 2 face to 1 wadding, although different proportions are used to suit different requirements. (5) In addition to the face

and wadding picks there are what are known as the **cutting picks;** these are the picks on which the backing ends are brought to the face for the purpose of pulling down the face cloth between the wadding picks, thus forming furrows across the cloth, and should be indicated on the design paper in some manner. (6) The number of picks between the cutting picks is determined by the design to be woven; however, if possible, there should be at least 2 picks of the face weave between the wadding picks and the cutting picks. (7) The face weave is placed on all the face ends, neglecting the backing ends and wadding picks entirely; this is done

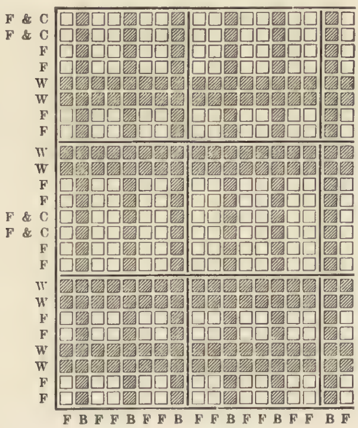


FIG. 26

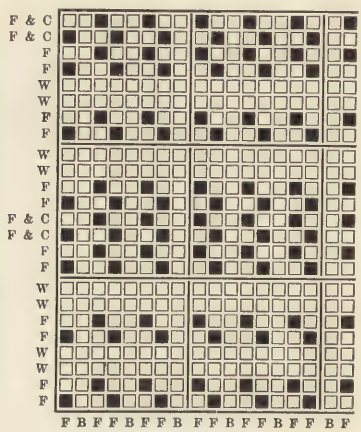


FIG. 27

in exactly the same manner as was explained with warp-backed fabrics. The face weave of piqués is generally the plain weave. (8) All the face ends are raised on the wadding picks. (9) All the backing ends are raised on the cutting picks.

17. Fig. 26 shows the design paper marked out for a piqué design occupying 18 ends and 24 picks. The shaded squares indicate those on which the backing warp and the wadding filling are to be placed. The ends and picks are also marked with the letters *F*, face; *B*, back; *W*, wadding; *F & C*, face and cutting. The next step in the formation

is the placing of the face weave on the squares that are not marked for back ends and wadding picks. Fig. 27 shows the design with the plain weave inserted for the face. The next step is to mark the design to show all the face warp ends raised on the wadding picks, since these are inserted so as to cause the face cloth to be pushed upwards between the cutting picks. The back warp must remain down on the wadding picks to bind the wadding picks to the fabric. The next step is to raise the backing ends on the cutting picks. This requires the backing ends to be raised on the eleventh and twelfth, also the twenty-third and twenty-fourth picks. The effect of this is to bind the backing ends to the fabric and pull down the face cloth to form a hollow place after a certain number of wadding picks have been inserted, in this case 4 picks, and after a certain amount of face cloth has been woven, in this case 6 picks.

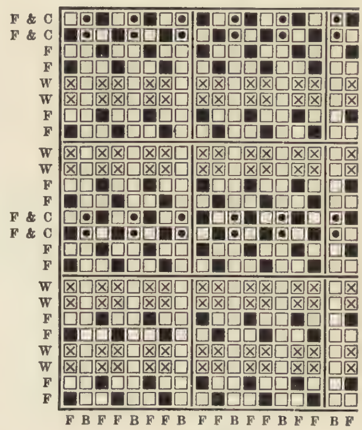


FIG. 28

Fig. 28 shows the design complete. The first 2 picks are plain, the backing ends being down and consequently not showing on the face at all. On the third and fourth picks, the wadding is inserted. While this is done all the face warp is raised, as shown by the crosses, and the back warp is down; consequently, the picks of wadding will lie in between these two series of yarns and will not show on the face, but being heavier than the face yarns will tend to raise the cloth constructed by the face weave. The next 4 picks are repetitions of the first 4 picks, and them come 2 more face picks. On the eleventh and twelfth picks, in addition to the plain weave of the face cloth, the backing warp is brought to the surface, as shown by the dots. These are the cutting picks. In weaving a piqué design, the backing warp is generally placed in a separate

beam that is weighted heavier than that containing the face warp, thus causing the backing warp to be under greater tension. When this backing warp is brought to the face, as it is under greater tension, it will of course tend to draw down the face yarns, thus causing a furrow between those parts of the cloth that contain the wadding picks.

The next 12 picks are but repetitions of the first 12 picks and consequently need no further explanation. Fig. 28 shows 6 repeats of the ends and 2 repeats of the picks, the design being complete on 3 ends and 12 picks. The design has been extended in this figure in order to show more clearly the construction of these weaves.

18. When studying the construction of a piqué design, it should be understood that the wadding picks do not show on the face of the cloth at any point, but simply lie between

FIG. 29

the face and back ends. Again, the backing ends do not show on the face of the cloth at all, except where they are raised for the purpose of pulling down the face cloth. Consequently, the face of a cloth woven with a design such as the one shown in Fig. 28 would be similar to plain cloth, with the exception of the raising of the cloth in ridges through the effect of the wadding picks, and also the floating of the back warp over 2 picks in certain parts of the cloth.

The position that the different ends and picks occupy when woven into cloth with this design is more clearly illustrated in Fig. 29, where a sectional view of 3 ends and 24 picks is shown. The heavy, dark line represents the backing end, while the other two lines running in the same direction show 2 face ends. The larger cross-sections marked *w* show the wadding picks, while the smaller cross-sections show the face picks. By referring to this figure it will be seen how the face picks interweaving with the face warp crowd over

the wadding picks, thus hiding them. It will also be seen how the backing end rising over the interlacings of the face filling and face warp draws them down, thus forming a furrow across the cloth.

DISSECTING A PIQUÉ

19. When dissecting fabrics of this type, the following points will be found to be of considerable assistance: (1) Find the proportion of face ends to the back ends by counting on the back of the cloth the number of backing ends per inch and then counting on the face of the cloth the number of face ends per inch. Suppose, for example, that there are found to be 30 backing ends and 60 face ends in an inch, then there are 2 face ends to every backing end and the pickout should be marked out in this manner. (2) Find the proportion of face picks to wadding picks. (3) Find the weave for the face cloth and place it on all the face ends, omitting the wadding picks. (4) Find the order of raising the back warp into the face; this can readily be done by taking a small part of the sample the wrong side up and pulling out the ends, one by one, instead of the picks, noting on the design paper whenever a back end is raised into the face cloth. (5) Raise all the face ends on the wadding picks.

20. In making the harness and chain drafts for a piqué design, the backing and face warps are drawn through separate sets of harnesses, as explained when dealing with cloths backed with warp. The backing warp is in most cases drawn through the back harnesses and the face warp through the front harnesses.

When piqué cloths are arranged 2 face to 1 back they are as a rule reeded 3 in a dent; that is, 2 face ends and 1 back end are drawn in each dent of the reed in such a manner that there will be 1 face end on each side of the back end in the dent. Piqués are high-pick cloths, the number of picks per inch being largely in excess of the number of ends per inch.

BEDFORD CORDS

21. Although Bedford cords have the same general appearance as piqués with the exception that the furrows run lengthwise of the cloth instead of across the cloth, their construction will be found to differ to a very large extent. Thus, in Bedford cords there will be found to be wadding ends instead of wadding picks. These wadding ends are held in the cloth by means of the same picks that form the face of the cloth instead of using backing picks, while 2 ends working plain throughout the entire length of the cloth form the furrow.

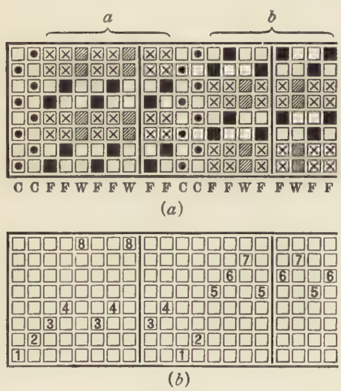


Fig. 30

Fig. 30 (*a*) shows one repeat of the ends and two repeats of the picks of a Bedford-cord design; the furrows lengthwise of the cloth, which are characteristic of Bedford cords, are formed by the first and second, also the eleventh and twelfth ends, which work plain throughout the cloth, while the weaves between them form the ridges. The parts of the design between the ends working plain are marked *a* and *b*. In section (*a*) the fifth and eighth ends, marked *W*, are the wadding ends. Dealing now only with the third, fourth, sixth, seventh, ninth, and tenth ends it will be noticed that they work plain on the first and second picks and are all raised on the third and fourth picks. This being one repeat of the design in its picks, the others are only repetitions of these first 4 picks. The effect of raising the ends in this manner is to cause the second and fifth picks and also the first and sixth to come together and thus produce a plain weave on the face of the cloth. It will also be noticed that on those picks on which all these ends are raised the wadding ends are also raised. The filling floating at the back will in this manner bind the wadding ends between the face

cloth and these picks of filling, not allowing the wadding ends to show on the face and yet holding them securely in position.

Referring now to section (*b*), it will be seen that this corresponds to section (*a*) with the exception that the position of the picks is reversed; that is, while in section (*a*) the face ends are working plain on the first and second picks, in section (*b*) they are all raised; and while in section (*a*) all the face ends are raised on the third and fourth picks, in section (*b*) they are working plain. Thus, the same picks, that are weaving plain to form the face cloth in section (*a*) are floating at the back to hold the wadding ends in section (*b*); and the reverse is also true.

The first, second, eleventh, and twelfth ends, which work plain throughout the cloth, will work tighter than the rest of the ends in the warp, and make the furrows between those parts of the cloth that contain the wadding ends.

DISSECTING A BEDFORD CORD

22. In dissecting a cloth of this character, the following points will be found of assistance: (1) Notice the ends that work plain throughout the weave and that form the furrows running lengthwise of the cloth; these are the ends that correspond to the first, second, eleventh, and twelfth ends in Fig. 30 (*a*). (2) Count the ends working plain on the face of the cloth in the raised portion between the furrows. It will be seen that in Fig. 30 (*a*) there are 6 ends. Then by looking at the back of the cloth the number of wadding ends can readily be determined, thus learning the proportion of face ends to wadding ends. (3) Arrange the ends on the design paper after the manner shown in Fig. 30 (*a*), taking care to have the wadding ends come between the face ends and also to have the face ends that are working plain in one section raised in the next, and vice versa.

It is not possible to pick out one of these cloths in the same manner as is done with cloths containing but one system of warp and one system of filling, but by having a

good general knowledge of their construction it is possible to learn the weave of any sample by simply studying the cloth by means of a pick glass. Bedford cords are high-sley goods and the number of ends per inch is always in excess of the number of picks per inch.

23. When making the drawing-in draft, the wadding ends are generally drawn through the back harnesses, while the face ends are drawn through the front harnesses. In reeding these cloths, each wadding end should be drawn into a dent with 2 or more face ends if possible. Fig. 30 (*b*) shows a drawing-in draft for Fig. 30 (*a*). In reeding the ends when drawn through the harnesses in this manner the best plan would be to draw 5 ends in a dent, commencing with the second end; that is, the second, third, fourth, fifth, and sixth ends would occupy one dent; the seventh, eighth, ninth, tenth, and eleventh, another; the twelfth, thirteenth, fourteenth, fifteenth, and sixteenth, another; and the seventeenth, eighteenth, nineteenth, twentieth, and first, another. This will bring each wadding end in a dent between 2 or more face ends.

WOOLEN AND WORSTED PLY WEAVES

INTRODUCTION

1. In the manufacture of woolen and worsted fabrics, and especially in the production of the former, it is often desired to make a heavier and warmer fabric than is possible when only two systems of yarns are employed, as in single cloths. Since it is desirable to produce a fabric with a fine face, the additional weight cannot be obtained by increasing the size of the yarns; nor is it feasible to increase the number of ends and picks in the fabric, because of the difficulty in weaving and the impossibility of making a level cloth. It therefore becomes necessary to add one or more systems of yarn, either of warp or filling or both, to the back of the cloth, thus producing what is known as a **ply fabric.** Ply fabrics are also often manufactured for the purpose of producing a cheap fabric that will have the weight of more costly cloths. This is readily accomplished by using cheaper yarns for that portion of the fabric that constitutes the back of the cloth; in this manner, the weight is gained, and a thicker and more substantial cloth produced at only a slightly increased cost, and without injuring the quality or appearance of the face of the goods.

2. Classification of Ply Fabrics.—There are two general classes of fabrics to which extra yarn is added for the purpose of giving thickness, weight, and warmth. The first class includes those fabrics to which only one system

of yarn is added (that is, cloths with a *backing* warp or filling); these are known as **backed cloths,** and are divided into *warp-backed fabrics* and *filling-backed fabrics.* The second class includes fabrics constructed of two or more distinct cloths stitched, or bound, together at intervals and consisting of two or more distinct series of both warp and filling; this class of fabrics includes *double* and *triple cloths*, which are made not only for gaining weight and warmth, but also, in many cases, for producing a double face on the goods, or to obtain two distinct effects, one on each side of the cloth. In a fabric of the latter description, the face of the cloth may be of a solid color, say blue, while the back of the fabric, which will form the lining of the garment when the cloth is made up, may show a plaid pattern, or vice versa. Such goods as these are frequently used for golf capes and overcoats, the fabrics being often three-ply cloths. Double cloths are largely used for suitings, both worsted and woolen, while backed fabrics are also used for suitings, trouserings, etc. to a large extent.

All fabrics having two or more systems of both warp and filling do not, of necessity, have the same number of systems of each, some having three warps and two fillings or three fillings and two warps, etc. Yarn added in this way to pure double or triple cloths is usually for tying purposes if warp yarn, and for wadding if filling yarn, to make the cloth heavier. Such fabrics could truly be called two-and-a-half-ply fabrics, etc.

BACKED FABRICS

FILLING-BACKED FABRICS

3. *Filling-backed cloths* are the simplest in structure of all ply fabrics, being somewhat simpler than warp-backed fabrics, since the latter involve special methods of constructing drawing-in and chain drafts. A **filling-backed fabric** may be considered as a single cloth consisting of one warp and one filling, but having bound, or tied, to the back an extra system of filling threads that are interlaced with the face cloth just enough to keep them attached and prevent their forming long, loose floats on the back of the cloth. This effect is obtained by so raising the warp yarn that when the face filling is inserted it will interlace with the warp according to the weave desired on the face of the cloth. When the pick of backing filling, however, is placed in the cloth, the whole warp is raised, with the exception of those ends that are depressed, in order to bind, or tie, the backing filling to the face cloth. This has the effect of making the pick of backing filling float on the back of the cloth, except where it passes over the few ends that tie it to the cloth. The method of attaching the backing yarn to the cloth is known as *binding*, *tying*, or *stitching*, and the places where the backing yarns are interlaced with the face cloth are known as the binding points, stitching places, tying points, ties, etc. These tying places should be so arranged that the backing filling will float over the warp thread between two floats of the face filling over the same end. The object of this is to cover the tying places so that they cannot be seen on the face of the cloth, the two floats of the face filling, one on each side of the float of backing filling on the face, crowding over the backing pick and thus hiding it from view.

Not only should the tying places be so arranged as to be

invisible on the face of the cloth, but they should also be distributed uniformly throughout the fabric so that the cloth will not cockle or finish unevenly. The best method of distributing the tying places is in satin order, as by this means not only are they evenly distributed, but all liability of the binding points forming twill lines on the face of the fabric is obviated. Many weaves, especially those constructed on a satin basis, can usually be tied in satin order when backed with warp or filling.

Although the method of distributing the tying places in satin order is the most satisfactory, because of the scattered, yet uniform, distribution of the interlacings of the backing filling with the warp, it often happens that the character of the face weave is such that the tying places cannot be distributed in this manner, and at the same time have each occur between two flushes of the face filling. When such is the case, it is always better to adopt some other system of binding rather than run the risk of having the backing yarn show on the face of the goods. The designer should always distribute the tying places as evenly and uniformly as possible; if not in satin order, then in some other regular order, so that each end will be depressed under the backing filling the same number of times. This is not so important when the backing filling is comparatively fine as when a coarse, heavy backing yarn is used. Sometimes a weave may be tied to advantage in broken crow order.

4. Filling-backed fabrics are made with 1 pick of face and 1 pick of back, with 2 picks of face and 1 pick of back, and also with 2 picks of face and 2 picks of back, etc. As filling-backed fabrics necessitate the use of two fillings, a box loom must be employed for their production, unless the same yarn is used for the backing filling as for the face filling. However, this is not usually the case, as the backing yarn is generally softer twisted, in order to give the fabric a soft, warm feeling, and in the majority of cases is also composed of cheaper material, and often of coarser yarn.

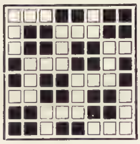


Fig. 1

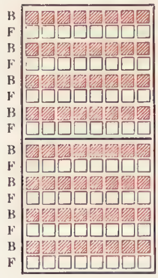


Fig. 2

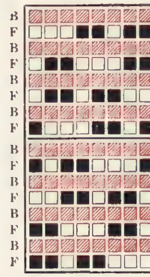


Fig. 3

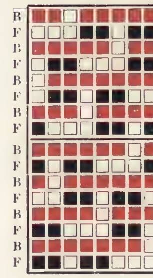


Fig. 4

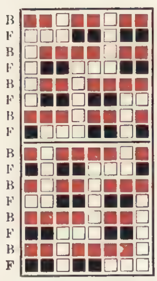


Fig. 5

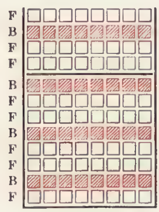


Fig. 6

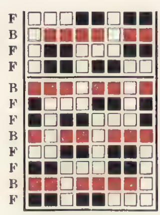


Fig. 7

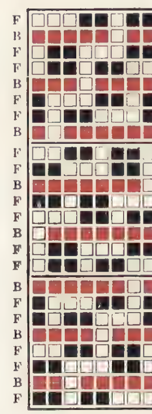


Fig. 8

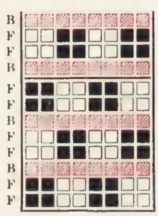


Fig. 9

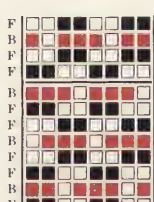


Fig. 10

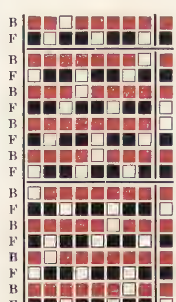


Fig. 11

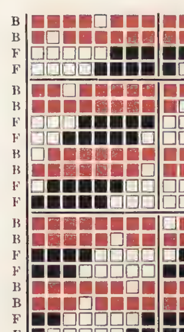


Fig. 12

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Weaves with 2 consecutive picks of face and 2 of back are necessary in case the cloth is woven in a loom with extra boxes on one side only, since with this type of loom it is not possible to put in a single pick of filling, as the shuttles always come to rest on the side of the loom that has the changeable boxes. Fabrics that have a single pick of backing filling require a pick-and-pick box loom, with changeable boxes on each side, unless, as previously stated, the backing filling is of the same yarn as the face filling. When, as is often the case, coarser yarn is used for the backing than is used for the face filling, the fabric should be made with 1 pick of backing and 2 picks of face, and sometimes in extreme cases 3 or even 4 face picks should alternate with 1 backing pick.

With filling-backed fabrics, it is impossible to form any fancy effects on the back of the fabric; and, in fact, this is not desired, the main object being to obtain a heavy- or medium-weight fabric, yet with a fine face produced with yarns of comparatively high numbers.

5. When making weaves for filling-backed fabrics, the first step is to indicate the face and backing picks on the design paper, in order that they may not be mistaken and the weaves placed on the wrong picks. If the design is to be composed of 1 pick of face alternating with 1 pick of backing, it is better to start at the bottom of the design and make the first pick a face pick. The second pick should be made a backing pick, and so on until sufficient picks on which to place the design have been marked. When a fabric is to be composed of 2 face picks alternating with 1 backing pick, it is customary to mark off the design paper 1 face, 1 back, 1 face. When the weave is made with 2 face and 2 back, it may be laid out 1 face, 2 back, 1 face. The above methods, of course, make no real difference in the weave and are not always used by any means. They are mentioned only in order that it may be understood that although the first pick of the weave may be a face pick and the next a backing pick, it may be laid out with 2 face picks alternating with

1 backing pick, since the next 2 picks may be face picks. When making a filling-backed weave of any description, care must be taken to have both the face and backing weaves evenly repeated on the face and backing picks, respectively. The method of backing must also be carefully considered in this connection; that is, whether the weave is arranged 1 face and 1 back or 2 face and 1 back, etc.

6. To illustrate the method of constructing filling-backed weaves, suppose that it is desired to back the 8-harness twilled basket weave shown in Fig. 1 with filling, the cloth to be woven with 1 pick of face and 1 pick of backing filling. The complete weave will require 16 picks, 8 picks for the face weave and 8 picks for the backing weave. The first operation in constructing the weave is to indicate which are to be the face and which the backing picks. This may be done in any convenient manner, it being advisable for a beginner to shade the backing picks with a pencil; in Fig. 2, the backing picks are indicated by the pink-shaded squares. The next step is to place the face weave (in this case Fig. 1) on the picks that have been indicated (in Fig. 2) as face picks. The method of doing this is shown in Fig. 3, and it should be carefully noted that as yet the backing picks remain unmarked. The pink-shaded squares in Figs. 2 and 3 do not represent the warp as lifted, but simply indicate which picks are the backing picks. The next operation is to place risers on the backing picks, raising all the warp ends except such as are left down to bind the backing filling to the fabric, thus, in reality, forming a backing weave. The method of accomplishing this is shown in Fig. 4, in which the backing weave is shown by red squares and where it will be seen that the warp ends are depressed to form the tying, or binding, points at those places where the face filling will float over the same end before and after the backing pick. Thus, the filling floats of the first and third picks will cover the tying place on the second pick, and similarly, throughout the whole design, each tying place will be covered by the face filling. It should also be noted that the tying places are

distributed in 8-end satin order, thus forming a perfect filling-backed weave. Both black- and red-filled squares, in Fig. 4, represent the warp raised over the filling.

In Fig. 4, the backing filling is bound into the cloth only once in 8 ends, but it is possible in this design, if a firmer fabric is desired, to increase the number of tying places, thus making the floats of the backing filling shorter. This may be done, as shown in Fig. 5, by arranging two tying places on each pick. In this weave, it will be noticed that the same perfect structure is retained, and that each end of the warp is depressed under the backing filling the same number of times, thus insuring equality of take-up in weaving.

Suppose that it is desired to back the same weave, Fig. 1, with a coarser backing filling, the cloth to be arranged with 2 picks of face and 1 of back. The design paper may be shaded off as shown in Fig. 6 and the weave constructed on the principles previously explained. In this case, however, only 12 picks will be required for the complete weave, 8 face and 4 backing picks. In order that each end of the warp shall take up the same in weaving, two ties must be placed on each backing pick and so arranged that each end will be depressed under the backing pick once; this is accomplished in Fig. 7, which represents Fig. 1 backed as stated. If it were desired to back the 8-harness twilled basket with filling having the weave arranged 2 face and 1 back and having the backing filling tied only once in 8 ends, it would be advisable to repeat the weave, as shown in Fig. 8, since by no other means would it be possible to have a tying place on each end. If, as is often the case, a face weave complete on a few ends and picks is used and it is desired to tie the backing filling loosely, repetition of the weave is necessary; while in many other instances repeating the weave will enable a more perfect tying arrangement to be used.

7. In arranging the face weave, it is important in many cases to consider its best relation to the backing weave. For instance, suppose that it is desired to back the 4-harness basket weave with filling and that the weave is placed on

design paper as shown in Fig. 9; in this case, there is no place where the backing can be raised for binding without having the warp up on one side, and, as previously explained, the stitching is liable to show on the face of the goods unless covered by face-filling floats. If, however, the face weave is placed on the design paper, as shown in Fig. 10, the backing can readily be stitched to the face, as shown, without any danger of its appearing on the surface. The back weave in this case is the broken crow weave.

Weaves that have a large percentage of warp on the face, especially warp-flush twills, are the hardest to back with filling, on account of there not being places in the weaves where perfect tying places can be arranged. When such weaves are backed with filling and it is impossible to have a face-filling flush on each side of the tying place, the design should be so arranged that the flush of face filling that is beside the tying place will follow rather than precede the tie. When the face-filling flush precedes the binding point, the tie will show up prominently on the face of the goods; but when the face flush follows the tie, the reed of the loom will push the face pick over the raised backing pick. This method is employed in Fig. 11, where the warp-flushed prunelle twill has been backed in the filling with the 9-harness satin. When filling-flush weaves are backed with filling, the tying places should be arranged as near the center of the face-filling floats as a regular system will allow, in order that the tie may be as well covered as possible.

Considerable ingenuity must occasionally be employed in tying the backing filling to the cloth, especially in cases where a coarse backing filling must be used and it is desirable to arrange the tying places so that each warp end will be depressed under the backing filling the same number of times. In fact, almost every weave requires some particular system of tying, and each should be carefully considered, in order to determine how it can be tied to the best advantage.

8. Fig. 12 shows the 10-end regular twill $\frac{5}{5}$ backed with filling, the weave being arranged 2 picks of face and 2 of

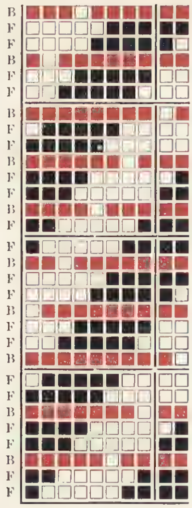


FIG. 13

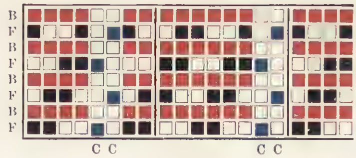


FIG. 14

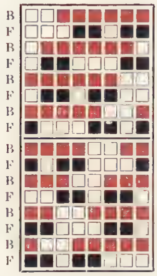


FIG. 15

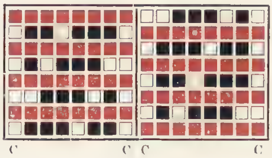


FIG. 16

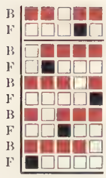


FIG. 17

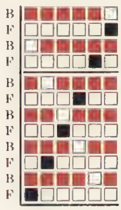
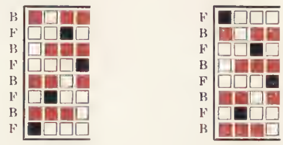
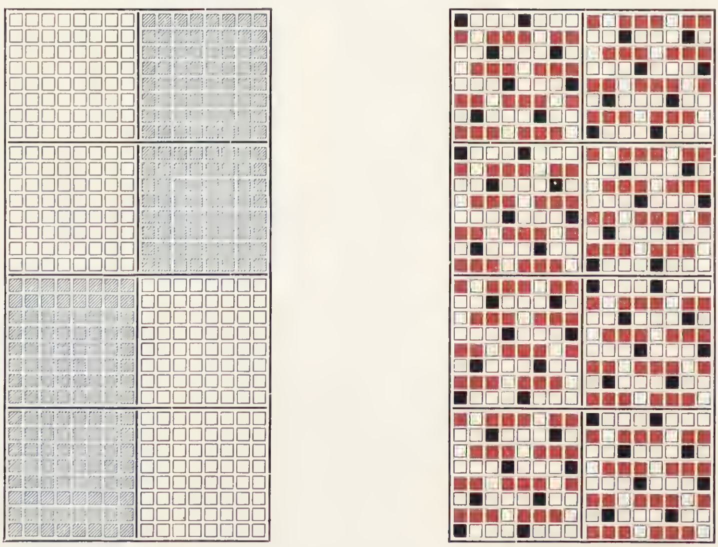


FIG. 18



(*a*) (*b*)

FIG. 19



(*a*) FIG. 20 (*b*)

back. The method of tying the backing filling should be particularly noticed in this design, as well as the arrangement employed in Fig. 13, which represents 2 repeats of the same twill backed with filling and arranged 2 face and 1 back. The tying places are arranged in two twill lines, being alternated so that each backing pick is tied once in the repeat of the weave and each end contains one tying point.

CUT FILLING-BACKED FABRICS

9. Cut filling-backed fabrics are generally made for trousering or suiting patterns and show on the face of the goods a fine *cut mark*, or indentation, running usually in the direction of the length of the piece. This cut mark is commonly produced by allowing the backing filling to float over certain ends of the warp throughout the weave; this also binds the backing filling to the cloth. When the cut marks are to be near together, it is usually unnecessary to bind the backing filling to the cloth in any other manner; but if the stripe between the cut marks is to be wide, it is advisable to bind the backing filling in the ordinary manner, in addition to where the cut is to be formed. Generally two cutting ends are used, and although both are depressed on every backing pick, they are usually arranged to work in plain order with the face picks.

In Fig. 14, the cassimere twill is shown backed with filling and arranged to form a stripe of 8 ends and then a cut. The backing filling floats over both cutting ends, which, however, as shown by the blue risers, work in plain order with the face filling.

If desired, the cut may be made to run diagonally across the cloth instead of lengthwise. This is sometimes done when backing twill weaves, the backing filling being arranged to float over the warp in the same direction as the twill of the face weave, thus making the cut accentuate the boldness of the twill. Fig. 15 shows the 8-end twilled basket weave backed with filling in such a manner as to make a diagonal cut mark.

10. When all the filling is of the same material, another method of producing cut marks may be employed. The filling yarn is brought to the face in one section, or stripe, and interweaves with the warp according to the face weave, while in the other section the same pick is allowed to float on the back of the cloth as a backing pick. Fig. 16 shows a design constructed on this principle, the face weave being the $\frac{3}{1}$ regular twill. The first pick is a face pick for the first section of 8 ends and then it passes to the back of the cloth and becomes a backing pick for 8 ends, when it comes to the face again. In the same manner, the second pick is a backing pick for 8 ends and then a face pick for 8 ends. In this way, a cut mark is made at the first and sixteenth and the eighth and ninth ends, where the filling is reversed. If a prominent cut mark is desired, the face weave should not be placed on the cutting ends, which should be left as shown in Fig. 16. Each pick is as much a backing pick as a face pick and vice versa, so that if a fabric of uniform appearance is to be made, the filling must all be of uniform size and quality.

FILLING REVERSIBLES

11. When filling-flush weaves are backed with filling interlacing with the warp after the same manner as the face filling, a reversible, or double-faced, fabric is formed having the same appearance on both sides; that is, if both fillings are of the same material and color. Satin weaves are generally used for these designs and the cloths are known as **satin reversibles.** Twill weaves are also used. In cloths of this description, the warp yarn is entirely concealed, being embedded between the two fillings, and consequently is usually of a cheaper material, cotton warps being largely employed.

Fig. 17 shows a 5-end satin reversible, which, if woven, would have a filling-flush satin face on each side of the cloth. If this weave is picked 1 black and 1 red, the face of the cloth will be black and the back red, since each color will show only on one side. Fig. 18 is a filling reversible weave with

the $\frac{1}{5}$ twill running to the right on each side of the cloth. When making weaves for this class of fabrics, the backing weave should be twilled in the opposite direction to the face weave, in order that it may run in the same direction when the cloth is turned over. In Fig. 18, it will be noticed that two of the tying places are not perfect; however, they have been arranged so that the face filling flush follows the tying point instead of preceding it. Then again as the backing and face filling in this class of fabrics are usually of the same material, there is not so much danger of the tying showing prominently on the face of the goods; that is, if the face filling and the backing filling are of the same color, as well as of the same material.

12. Figured Filling Reversibles.—Designs for figured filling reversibles are usually made, according to a given motive, with two filling reversible weaves, one arranged to throw the odd-numbered picks on the face and the even-numbered picks on the back, and the other arranged to produce the opposite effect. Thus, if the weave is picked, say, 1 white and 1 green, the motive will be reproduced in white on a green ground on the face of the goods, and in green on a white ground on the back of the cloth, or vice versa. Since the warp is entirely hidden in the fabric, cotton warps are commonly used and the fillings are of equally good quality. Any two filling reversible weaves may be used in constructing designs of this description, but those complete on a small number of ends and picks are to be preferred if the motive is comparatively small. Take, for instance, Fig. 19 (*a*) and (*b*). In both of these weaves, the filling-flush broken crow weave is backed with filling tied in broken crow order; in other words, both are filling reversibles. In (*a*), however, the odd-numbered picks are the face picks and the even-numbered picks the backing picks, while in (*b*) the reverse is the case; so that if these designs are woven, say, 1 white and 1 green, (*a*) will produce a cloth white on the face and green on the back, and (*b*) a cloth green on the face and white on the back. It will be seen, therefore, that

these two weaves may be combined to produce figured effects.

The arrangement of the weaves, as already stated, is usually accomplished according to a given motive. Suppose, for instance, that a simple checker-board effect, with square figures arranged in plain order, is desired; then all that is necessary is to lay out the motive the required size, and place the weave shown in Fig. 19 (*a*) on it, and that shown in Fig. 19 (*b*) on the ground, or vice versa. When arranging the motive for the reception of the weaves, it should be enlarged twice as much filling-way as warp-way, since filling-backed weaves arranged 1 face and 1 back require twice as many picks as ends to give the same number of face or backing picks as ends, or, in other words, to give a squarely built texture to the face and back. If the motive were not laid out in this manner, the length of the check or other figure, as the case might be, would be reduced one-half, which would cause it to appear distorted. The assumption in this case is, of course, that it is desired to construct the cloth with as many face or backing picks as ends per inch; if, however, the proportion of face or backing picks to ends is different, the weave must be constructed accordingly, in order to retain the symmetry of the motive. Fig. 20 (*a*) shows a motive for a checker-board effect, the light-blue-shaded squares indicating the motive and the blank squares the ground. Fig. 20 (*b*) shows the check effect constructed with the weaves shown in Fig. 19 (*a*) and (*b*), Fig. 19 (*a*) being placed on the motive and Fig. 19 (*b*) on the ground. If this design were woven with 1 pick of white and 1 pick of green filling, a white-and-green check would be made on both sides of the cloth, which would be of the reversible type, the green portion on the face covering a white check on the back, and vice versa. Other weaves than Fig. 19 (*a*) and (*b*) may easily be made, and any suitable motive may be used as a basis for combining them to produce figured filling reversible cloths.

EXAMPLES FOR PRACTICE

1. Construct a filling-backed weave arranged 1 face, 1 back, using the $\frac{4}{4}$ regular twill as a face weave and tying the backing filling perfectly on each warp end.

2. Make an 8-end satin filling reversible weave arranged 1 face and 1 back.

3. Back the cassimere twill with filling, the weave to be arranged 1 face, 1 back, and to be capable of being woven on 4 harnesses.

4. If a 12-end regular twill is backed with filling, the weave being arranged 1 face, 1 back, 1 face, on how many ends and picks will the design be complete, supposing that only 1 repeat of the face weave is shown?

5. Back the $\frac{2\ \ 2\ \ 1}{\ \ 2\ \ 2\ \ 1}$ regular twill with filling, arranging the weave 1 face, 1 back. Tie each backing pick once in 10 warp ends.

6. Back the $\frac{3}{1}$ twill twilled to the left with the 8-end satin, arranging the design 1 face, 1 back, and being careful to have the float of face filling follow, rather than precede, the tying point.

WARP-BACKED FABRICS

13. Warp-backed fabrics are cloths constructed with one system of filling yarn and two systems of warp yarn, in which one system of warp interlaces with the filling to form the face of the cloth, while the other floats on the back of the cloth for the purpose of adding weight and warmth to the fabric. Warp-backed fabrics are similar in construction to filling-backed fabrics, with the exception that the backing yarn is warp instead of filling. They require more harnesses than filling-backed fabrics, because of the extra, or backing, warp, but on the other hand may be woven on single-box looms; that is, if the filling is of the same color and material throughout. The same length of time is required to weave warp-backed cloths as single cloths, since the former require only as many picks as the latter; a longer time is necessary, however, for the weaving of filling-backed fabrics, owing to the extra picks of backing filling that must be put into the cloth.

Color also can be applied to the back of warp-backed fabrics to advantage, since stripe effects can be easily made, while with filling-backed cloths only bars across the cloth can be produced, and this is rarely a satisfactory method of applying color. However, particular care should be taken, in all cases where a different color from that of the face yarn is applied to the reverse side of backed cloths, to have all binding points perfect, so that the color of the backing yarn will not show on the face of the goods.

In many warp-backed cloths, two beams are required, since the backing warp is often a coarser yarn and also interlaces differently with the filling than the face warp, except in the case of warp reversibles. It is necessary for the backing yarn in a warp-backed fabric to be harder twisted than the backing yarn in a filling-backed fabric, since there is always more strain on warp than on filling yarn. Thus, it will be seen that warp-backed fabrics are generally harsher and stiffer feeling goods than filling-backed fabrics, in which soft-twisted yarns are almost exclusively used for the backing filling. Warp-backed cloths are largely used for producing heavy fabrics with a cheaper back than face, as for instance, worsted suitings and trouserings with a fine worsted face and woolen back. However, if very cheap and tender yarn must be used for the back, a filling-backed weave is to be preferred.

14. In constructing weaves for this type of fabric, there are several important points that should be noted: (1) The backing warp must be raised over a pick in every instance where it is desired to bind the back to the face cloth. With filling-backed fabrics the reverse is the case; there a warp end is depressed in order to bind the extra system of yarn to the cloth. (2) In warp-backed fabrics, the tying places should always be placed between two warp flushes of the face cloth, if possible, in order that the tying may not show on the face of the goods; if in any case this is impossible, the backing warp should be raised either to the right or to the left of a face-warp flush, although the most perfect

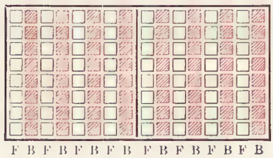


FIG. 21

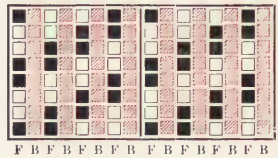


FIG. 22

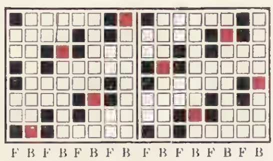


FIG. 23

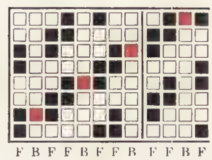


FIG. 24

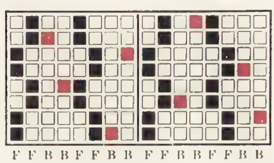


FIG. 25

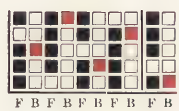


FIG. 26

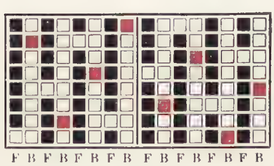
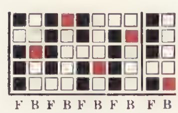
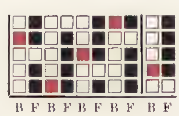


FIG. 27



(*a*)



(*b*)

FIG. 28

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results cannot be obtained by this means. (3) If there are a great many more intersections of the face warp with the filling than of the backing warp with the filling in a given number of picks, or if one series of warp yarn is coarser, it will be necessary to place the two warps on separate beams, since the take-up of the warps in weaving will be different. (4) It is always best to select weaves of regular structure, such as satins, twills, broken crow, etc., for the backing weave, so that each backing end will have the same number of interlacings. (5) Care should be taken to have the face and backing weaves repeat evenly on the design, so that the number of ends in the complete design will be the least common multiple of the number of ends in the two weaves; that is, supposing the design to be arranged 1 face and 1 back. Warp-backed fabrics, however, are often arranged with 2 ends of face and 1 end of back, and sometimes with 2 ends of face and 2 of back. Care should be taken, though, in any case, to have the face and backing weaves evenly repeated.

In addition to the above, there are often many other things to be considered when constructing weaves for warp-backed cloths. For instance, if a design of this class is arranged 1 face and 1 back, the backing warp should never be of heavier yarn than the face, since, if this is the case, the back is liable to show through on the face of the cloth. If the design is arranged 2 face and 1 back a proportionately heavier yarn can be used for the backing warp. If cheaper material is used for the backing warp and the cloth is to be fulled, a backing yarn of as nearly as possible the same fulling properties as the face yarn should be used.

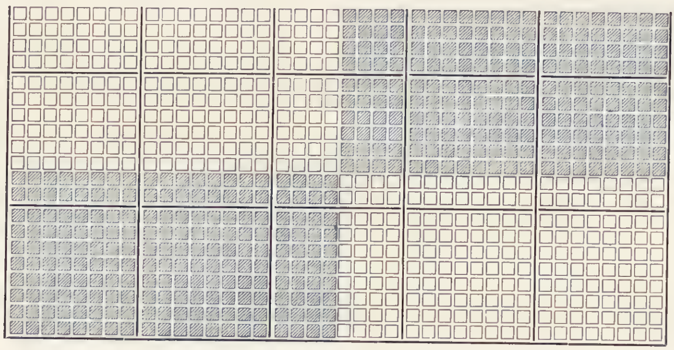
15. To illustrate the method of constructing a warp-backed weave, suppose that it is desired to back the cassimere twill with warp, using the 8-harness satin weave on the back of the goods, or in other words tying the backing warp in 8-end satin order, the design to be arranged 1 face warp and 1 backing warp. As the backing weave in this case will require 8 ends, it will be necessary to show two repeats of the face weave in the complete design; therefore, the

finished weave will require 16 ends and 8 picks. The first operation is to shade, or in some manner indicate, the backing ends, in order that they may be distinguished from the face ends. The method of doing this is shown by the pink-shaded squares in Fig. 21, where the design paper is prepared for the reception of the face weave. Fig. 22 shows the cassimere weave, which is used for the face weave in this design, placed on the face ends. The final step is to place the backing weave on the design. As the backing weave, which is to be the 8-harness satin, must flush on the back of the cloth, it should be raised only once in 8 picks on each backing end and in satin order, as shown by the red squares in Fig. 23. The method of raising the backing warp at the tying places between two face-warp flushes should be noted carefully, the object, of course, being to allow the flushes of face warp to cover and hide the tie.

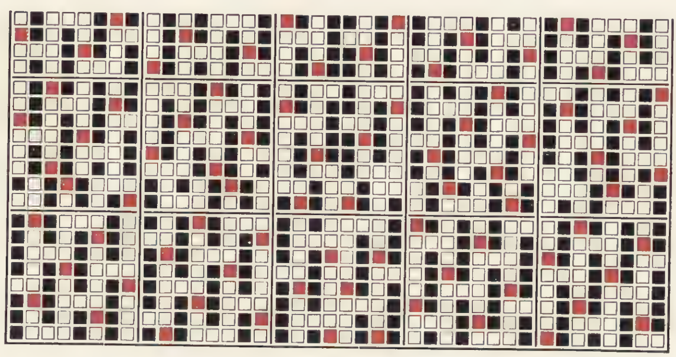
Fig. 24 shows the cassimere twill backed with warp, arranged 2 ends of face and 1 end of back, the backing warp being tied in regular twill order. Fig. 25 is a warp-backed weave having a 4-harness basket face weave backed with the 8-end satin, the design being arranged 2 ends of face and 2 ends of backing warp.

WARP REVERSIBLES

16. Double warp-faced fabrics are made with the reverse face put on with warp in a somewhat similar manner to that employed in filling-reversible cloths, and like them are generally made with satin weaves, the face warp flushing on the face of the cloth and the backing warp on the back. Weaves for these cloths are constructed as for other warp-backed fabrics, but the backing warp is usually of as good quality as the face, while the filling, as it is entirely concealed in the fabric, may be of cotton or other cheap material. Since both the face and backing warps interlace with the filling in the same manner, cloths of this description require only one beam for weaving. Fig. 26 shows a 5-harness and Fig. 27 an 8-harness warp satin reversible, both being



(*a*)



(*b*)

Fig. 29

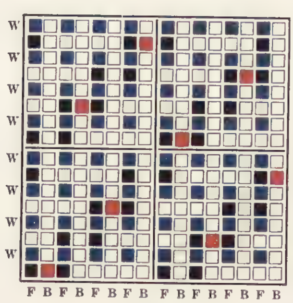


Fig. 30

arranged 1 face and 1 back and both having perfect tying places.

17. Figured warp reversibles may be constructed in a similar manner to that employed in producing figured filling-reversible effects, with the exception that the designs are constructed by amalgamating two warp-reversible weaves instead of two filling-reversible weaves. The design is usually figured, according to a given motive, with these two warp reversibles, one of which is arranged to throw the odd-numbered ends on the face and the even-numbered ends on the back, and the other to produce the opposite effect; thus, if the cloth is warped 1 white and 1 black, the motive will be reproduced in white on a black ground on the face of the cloth and in black on a white ground on the back of the cloth, or vice versa. Since the filling is entirely hidden in the fabric, cotton filling is commonly used; but the warp yarns should be of equally good quality, since the warp alternately appears on the face and back of the cloth. Any two warp-reversible weaves may be used in constructing designs of this description, but those complete on a small number of ends and picks will be found most convenient. Fig. 28 (*a*) shows a warp-reversible weave constructed with the 5-harness satin on the face and back, while Fig. 28 (*b*) shows the same reversible weave with the exception that in (*a*) the odd-numbered ends are the face ends and the even-numbered ends the backing ends, while in (*b*) the reverse is true. If these designs are warped 1 white and 1 green, (*a*) will produce a cloth with a white face and a green back, while (*b*) will produce a cloth with a green face and a white back. Therefore, if these two weaves are combined according to a proper motive, a figured effect will be obtained.

Suppose, for instance, that a simple checker-board effect consisting of square figures arranged in plain order is desired; then in order to form a figured warp reversible all that is necessary is to lay out the motive to the required size and place Fig. 28 (*a*) on the motive and Fig. 28 (*b*) on the ground, or vice versa. When arranging the motive for the reception of

the weaves, it should be enlarged twice as much warp-way as filling-way, since warp-backed weaves arranged 1 face and 1 back require twice as many ends as picks to give the same number of face or backing ends as picks per inch. If the motive is not laid out in this manner, the width of the check or other figure, as the case may be, will be reduced one-half, while the length will remain the same, that is, if there are the same number of picks as face ends, which will cause it to appear distorted. Fig. 29 (*a*) shows the motive for the desired check effect, the light-blue-shaded squares indicating the motive and the blank squares the ground. Fig. 29 (*b*) shows the weave for the check effect desired, constructed with the weaves shown in Fig. 28 (*a*) and (*b*), Fig. 28 (*a*) being placed on the motive and Fig. 28 (*b*) on the ground. If this design, therefore, is warped 1 white and 1 green, a white-and-green check will be made on both sides of the cloth, which will be of the reversible type, a green check on the face covering a white check on the back, and vice versa.

Other weaves than Fig. 28 (*a*) and (*b*) may easily be made, and any motive may be used as a basis for combining them to produce warp-reversible fabrics. For instance, if the first 5 picks of Fig. 29 are considered as the complete weave and the warp is arranged 1 white and 1 green, a white-and-green reversible stripe will be produced.

WARP-BACKED CLOTHS WITH A WADDING FILLING

18. In some cases, the required weight cannot be obtained by backing with warp alone and at the same time the appearance and texture of both the face and back of the fabric be retained. When this is the case, extra picks of filling, known as **wadding picks,** may be inserted in such a manner that they will not show either on the face or back of the cloth. In order to obtain this result, it is only necessary to raise all the face warp and depress all the backing warp when the wadding pick is inserted, thus laying the pick between the two warps, but not interlacing it with either.

The wadding filling may be of any cheap material, as it does not show at all, but should not be much larger in size than the face warp if a level cloth is desired. Fig. 30 shows the warp-backed weave shown in Fig. 23 arranged alternately with 1 pick of face filling and 1 wadding pick. The blue squares show the face warp raised over the wadding picks.

DRAFTING OF BACKED WEAVES

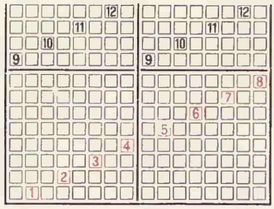
19. Filling-backed weaves, since they contain only one system of warp yarn, may be drawn through the harnesses, and the chain and drawing-in drafts constructed exactly the same as for a single cloth. In these weaves, only as many harnesses are required as are necessary for producing the face weave. In the case of warp-backed fabrics, however, since the backing warp interlaces with the filling differently from the face warp, it must be drawn in on separate harnesses; therefore, in these fabrics, one set of harnesses is required to produce the face weave and an additional set to govern the interlacings of the backing ends. A warp-backed weave may be drawn in exactly as a single cloth, if it is so desired. In this case, if the weave is arranged 1 face and 1 back, the first harness will be a face harness, the second harness will have the backing warp drawn through it, etc., each alternate harness being a backing harness; that is, with a straight draft. If the weave were arranged 2 face and 1 back, 1 backing warp harness would alternate with 2 face harnesses. This method of drafting is adopted in some instances in connection with warp-backed fabrics of simple design, but in the majority of cases it is desirable to separate the harnesses for the backing warp from those through which the face warp is drawn, since this method makes the harness draft much simpler for the weaver, thus rendering the liability of broken backing warp ends being tied in on face harnesses, or vice versa, less probable.

There are two systems of separating the harnesses through which the backing warp is drawn from those through which

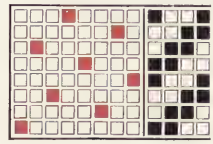
the face warp is drawn. The first method consists of drawing the backing warp on the back harnesses and the second of drawing the backing warp on the front harnesses. Both of these systems are largely in use, but the latter method is to be preferred, as by this means the backing warp is more readily accessible to the weaver, and since the backing ends are frequently of poorer material and break oftener, this is somewhat of an advantage. For the same reason, namely, that the backing ends are often weaker than the face ends, it is an advantage to place the backing warp on the front harnesses, since the harnesses in the rear are lifted higher than those in the front of the loom, thus bringing more strain on the yarn drawn in on those harnesses. If, however, the face warp has a fancy pattern, it is better to draw it on the front harnesses.

20. To illustrate the method of making the drafts for a warp-backed weave, suppose that it is desired to construct harness and chain drafts for Fig. 23. The first step is to make the harness draft, which is accomplished in identically the same manner as with single cloth, except that two processes are required in order to draft both the face and backing weaves. It will be supposed in this case that the backing warp is to be drawn on the front harnesses. The drawing-in draft for the backing weave will therefore be made first, and as in this case the backing weave is an 8-harness satin it will require 8 harnesses. Proceed exactly as in single cloth, taking care, however, as Fig. 23 is arranged 1 face and 1 back, to leave every other vertical row of squares of the harness draft for drawing in the face warp. Next, indicate the drawing-in draft for the face weave, placing it above the draft for the backing weave, but on the vertical rows of squares reserved for the face warp. As the face weave in Fig. 23 occupies but 4 harnesses, there will be two repeats of the face drawing-in draft to one repeat of the draft for the backing weave.

Fig. 31 (*a*) shows the drawing-in draft for Fig. 23 with the backing warp drawn through the first 8 harnesses and the

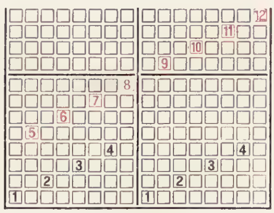


(a)

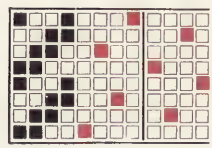


(b)

Fig. 31

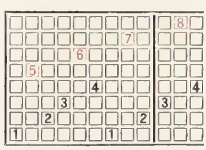


(a)

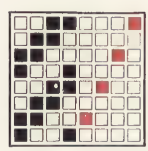


(b)

Fig. 32



(a)



(b)

Fig. 33

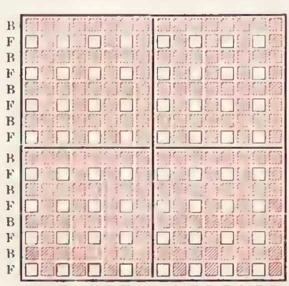


Fig. 34

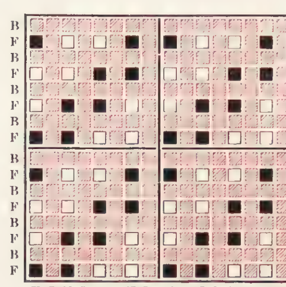


Fig. 35

face warp through the last 4 harnesses, as explained. Care should always be taken to arrange the alternation of the face and backing ends in the drawing-in draft exactly the same as they occur in the weave; that is, if the first end of the weave is a face end, the first end of the drawing-in draft must be drawn through a face harness, and if the second end of the weave is a backing end, it must be drawn through a backing harness. Thus, in Fig. 31 (*a*), the end drawn through the first harness is the first backing end, which is the second end of the weave; therefore, this end occupies the second vertical row of squares in the drawing-in draft. Having obtained the drawing-in draft as shown in Fig. 31 (*a*), it is a comparatively simple matter to construct the chain draft, the method being identical with that employed in a single fabric. Since the drawing-in draft is arranged to separate the face and backing warps, the face and backing weaves are separated in the chain draft, as shown in Fig. 31 (*b*), which shows the chain draft for Fig. 23 with the warp drawn in as shown in Fig. 31 (*a*).

21. If it is desired to draft Fig. 23 with the backing warp drawn in on the back harnesses and the face warp on the front harnesses, the drawing-in draft will be made as shown in Fig. 32 (*a*) and the chain draft as shown in Fig. 32 (*b*). The method of constructing the drafts in this case is exactly the same as for Fig. 31 (*a*) and (*b*) with the exception, of course, that in this case the face warp is drawn in on the harnesses at the front of the loom.

When drafting warp-backed weaves that are arranged 2 ends of face and 1 of back, the same methods are employed as previously explained, except that 2 face ends are drawn consecutively on the drawing-in draft in accordance with the arrangement of the face ends in the weave. The drawing-in draft for Fig. 24 is a draft of this description, as shown in Fig. 33 (*a*). Fig. 33 (*b*) shows the chain draft for Fig. 24 with the warp drawn through the harnesses according to Fig. 33 (*a*).

EXAMPLES FOR PRACTICE

1. Back the $\frac{4}{2}$ regular twill with warp, arranging the design 1 face and 1 back and tying each backing end perfectly.

2. Back the $\frac{4}{2}\frac{3}{3}$ regular twill with warp, arranging the ends 1 face and 1 back. Tie the backing warp in 12-end satin order.

3. Make a design for a warp-backed fabric having the $\frac{3}{1}$ regular twill on the face and the 8-harness satin weave on the back, arranging the warp ends 1 face and 1 back. Show harness and chain drafts with the backing warp drawn in on the front harnesses.

4. Back the $\frac{4}{1}$ regular twill with warp arranging the design 1 face, 1 back, 1 face. Tie the backing warp in 5-end satin order. Show harness and chain drafts with the face warp drawn in on the front harnesses.

5. Make an 8-end warp satin reversible arranged 1 face and 1 back.

6. Back the $\frac{3}{1}\frac{2}{2}\frac{1}{3}$ regular twill with warp, arranging the design 1 face and 1 back. Tie the backing warp in regular order, each end to be tied once in 12 picks.

DOUBLE AND TRIPLE CLOTHS

DOUBLE CLOTHS

22. The term **double cloth** includes those fabrics that consist of two separate cloths, which may be woven in the loom independently, one above the other, or which may be bound together by allowing threads of one cloth to interlace at certain intervals with those of the other. Two systems of both warp and filling are required for the production of a double cloth, while for a backed cloth only one system of backing yarn is necessary. A double cloth may be considered as a combination of a warp- and a filling-backed fabric; that is, it may be considered as a fabric backed with both warp and filling, requiring not only extra harnesses in the loom but also extra filling and generally extra shuttles. In a double cloth, however, the backing warp and filling interlace with each other according to a definite weave, which may be the same as, or different from, the face weave. If a

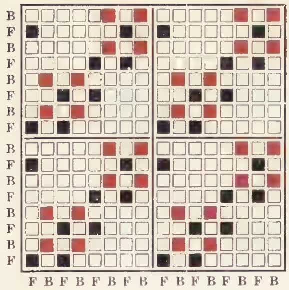


Fig. 36

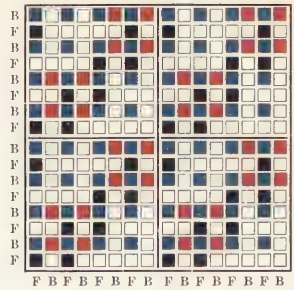


Fig. 37

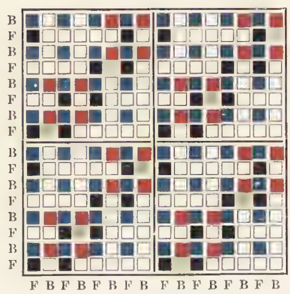


Fig. 38

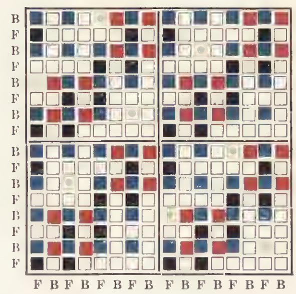


Fig. 39

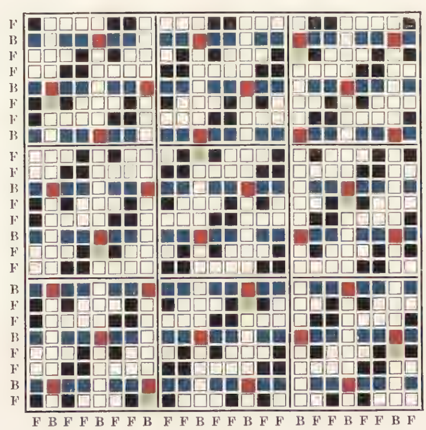


Fig. 40

double cloth, therefore, is woven without binding, or tying, the face and back fabrics together, two separate cloths will be formed in the loom, one on top of the other and only fastened together at the selvages. On the other hand, if a backed fabric were woven without tying the backing warp or filling, as the case might be, the face cloth would be formed perfectly, but the backing yarns would not interlace at all.

There are many objects that lead to the production of double cloths, among which may be mentioned: (1) To reduce the cost of heavy-weight fabrics by the addition of cheaper material to the back of the goods; (2) to produce heavy-weight fabrics, the face of which shall be composed of comparatively fine yarns; (3) to produce double-faced fabrics having the same appearance on each side; (4) to produce double-faced fabrics having a different appearance, or pattern, on each side.

23. In constructing double-cloth weaves, they may be arranged 1 face and 1 back in both warp and filling, or 2 face, 1 back, etc. Sometimes double-cloth weaves are arranged 1 face and 1 back in the warp and 2 face and 1 back in the filling, or vice versa. To illustrate the method of constructing a double-cloth weave, suppose that it is desired to back the cassimere twill with a 4-end basket weave, the design to be arranged 1 face and 1 back in both warp and filling, and tied in 8-end satin order. Since the weave is to be arranged 1 face and 1 back and the stitching weave alone requires 8 ends and 8 picks, 16 ends and 16 picks, or 8 backing and 8 face ends and picks, will be required to show one repeat of the completed weave. As both the face and backing weaves are complete on 4 ends and 4 picks, they will be repeated evenly on the 8 face and backing ends and picks, respectively.

The first step in the construction of the weave is to indicate, by some arbitrary method, which ends and picks are to be the face, and which the backing, ends and picks. This may be conveniently accomplished by shading each backing end and pick, as shown by the pink-shaded squares in Fig. 34. The next operation is to place the face weave on the design

paper, as shown in Fig. 35, opening it out both warp- and filling-way, in order that it may be placed on those ends and picks that have been indicated as face threads. After placing the face weave on the face ends and picks, the next step is to place the backing weave on those ends and picks that have been indicated as the backing ends and picks, as shown by the red squares in Fig. 36. In order that the backing filling shall not interlace with the face warp and thus show on the face of the goods, it is next necessary to raise every face thread on each backing pick. This is accomplished by raising the face warp at each intersection with the backing filling, as shown by the blue squares in Fig. 37. The weave completed to this stage would, if woven, produce two perfect and entirely distinct pieces of cloth, one woven with the cassimere twill and the other with the 4-end basket weave. In order, therefore, to so amalgamate these two fabrics as to produce a double cloth, it is necessary to bind, or tie, them together.

24. There are two methods of tying ordinary double cloths. The first, and the one adopted in the majority of cases, is to raise each backing end in regular order over a face pick. Care should be taken in doing this to raise the backing end in the same manner as in the case of warp-backed fabrics; namely, between two face warp flushes on the same pick. If possible, it is also always best to have the tying places occur on each of the backing ends an equal number of times in a given number of picks, thus making each end of the backing warp take up the same in weaving. The second method of stitching a double cloth is to depress the face warp threads under the backing filling, making the system of tying as uniform as possible and binding each face-warp thread, in order that the face warp shall take up evenly in the weaving. When tying by this method, the face warp should be depressed, or in other words the backing filling should be raised, in such a manner that the tying places will occur between two flushes of the face filling, as when tying filling-backed fabrics. This method of tying

double cloth is not used so much as the first method, but is useful in tying cloths that have a predominance of filling on the face; that is, in cases where the face weave is a filling-flush weave.

The completed design for the double-cloth weave under consideration, tied by raising the backing-warp ends over the face picks in 8-end satin order, as indicated by the green squares, is shown in Fig. 38. As each tie is formed by raising the backing end between two flushes of the face warp over the same picks, the ties will be concealed from the face of the goods. The distribution of the ties in this case is perfect, since each backing-warp end has the same number of ties. It is always better to use a satin order for the ties, if possible, since the regular, yet distributed, order of the binding points always makes a perfect cloth with no liability of its cockling. In Fig. 39, the same double-cloth weave is shown as in Fig. 38 with the exception that the stitching is accomplished by allowing the backing picks to float over the face ends. The binding is shown by the green dots, but it should be remembered that in this case it is done with sinkers and not with risers, since each tying place represents the backing filling floating over the face warp. The binding is shown by green dots simply to show the position of the tying points more clearly; the squares thus represented should actually be blank squares.

In tying double cloths, it should always be borne in mind that in all perfectly tied double cloths there are the same number of binding places on each backing or face end, according to whether the cloth is tied with the backing warp or filling, and that when the face weave is a warp-flush weave it is better to tie the cloth by raising the backing warp, as the tying will then be covered as well as possible, but when the face weave is a filling-flush weave, it is better to tie the cloths by raising the backing filling, as the flushes of face filling will then cover the tying places to the best advantage. The binding of double cloth also has an influence on the ultimate character of the fabric, since the oftener the cloth is bound, that is, the more tying places there are, the harder

and firmer the fabric will feel, while if tied only at wide intervals the cloth will feel loose and spongy.

25. If, when designing a double-cloth weave with a twill on the back, it is desired to have this twill run to the right, it must be made to run to the left on the design paper, and vice versa. If it is desired to have a warp-flush weave on the back of the cloth, the reverse, or filling-flush, of the desired weave must be placed on the design paper. The reason for this is that the backing weave will always be seen from the under, or reverse, side after the cloth is woven. Care should always be taken, when arranging the weaves for a double cloth, to arrange them in such a manner as to make the best possible places for tying the cloths together.

26. Double-cloth weaves are often constructed so as to be woven with twice as many face as backing ends and picks. Fig. 40 shows a weave of this description arranged 1 face, 1 back, 1 face in both warp and filling; the face weave is the cassimere twill and the backing weave plain. The two cloths are bound together by raising the backing warp over the face filling in 8-end satin order. The double-cloth weave shown in Fig. 41 is arranged 3 face and 1 back. The face weave is the 6-end regular 45° twill $\frac{3}{3}$, while the backing weave is the cassimere twill. In this weave, the ties are evenly distributed on each twill line of face-warp floats, which is accomplished by twilling the binding points in the opposite direction to the twill of the face weave. This arrangement of the face and backing yarns is suitable for goods with a fine worsted face and a woolen back; the method of constructing the weave is the same in principle as one-and-one and two-and-one double-cloth weaves.

It often happens that the same proportion of face and back is not used in the warp as in the filling of a double cloth. The design shown in Fig. 42 is of this type, as it is arranged 1 face and 1 back in the warp and 1 face, 1 back, 1 face in the filling. The face weave is the cassimere twill, while the backing weave is the small rib weave shown in Fig. 43. The face and back cloths are bound together in 8-end satin order

in this weave. Another double-cloth weave of unevenly balanced construction is shown in Fig. 44, in which the warp is arranged 1 face, 1 back, 1 face, and the filling 1 face, 1 back. The face weave is the cassimere twill and the backing is the plain weave; the two cloths are tied on the warp-flush twill line of the cassimere.

When making double-cloth weaves where two backing ends are placed together, care should be taken to have the tying places on the two backing ends that are together on different picks, so as to allow the face ends to cover them perfectly. In the weave of this description, shown in Fig. 45, careful notice should be taken of the method of tying. In this design, the face weave is the regular 8-harness twill $\frac{4}{4}$, while the backing weave is the cassimere twill.

TYING WITH A COTTON WARP

27. Double-cloth weaves are often arranged to be tied with an extra system of cotton threads instead of with the yarns that compose the face and back cloths, as in the ordinary methods of binding. The cotton tying threads are generally wound on a spool, which is placed at the back of the loom in such a manner as to let off the tying yarn as the cloth is woven. The tying threads are arranged in the weave so as to float over every backing pick and under every face pick, except at certain points where they are raised over a face pick between two floats of the face warp over the same pick and certain other points where they are allowed to be depressed under a backing pick between two backing ends that are also depressed, that is, that float on the back of the fabric. The alternate interlacing of this system of tying threads first with the face and then with the back fabric serves to bind the two cloths securely together, although a fabric tied in this manner is never so firmly bound as one tied by raising the backing warp or filling into the face cloth. Fig. 46 shows a double-cloth weave having the cassimere twill on the face and back and tied with a cotton warp. The weave is arranged 1 face, 1 back, 1 tying in the warp and

1 face, 1 back in the filling. It will be noted that each tying end passes over 1 face pick, as shown by the filled green square, and under 1 backing pick, as shown by the shaded green square which indicates the warp depressed, but at all other points lies between the face and backing picks, being raised over the backing picks, as shown by the blue dots, but floating under the face picks.

DOUBLE-CLOTH WEAVES WITH WADDING YARNS

28. Double-cloth weaves are sometimes arranged with a wadding warp or filling, generally the latter, for the purpose of adding weight and bulk to the goods by inserting cheaper material between the face and back cloths in such a manner that it will not show on either the face or back of the fabric. A double-cloth weave arranged with a wadding filling is shown in Fig. 47. Both the face and the backing weaves in this case are the cassimere twill, and the cloth is tied perfectly in 8-end satin order. The weave is arranged 1 face, 1 back in the warp and 1 face, 1 back, 1 wadding in the filling. When a pick of the wadding yarn, which is usually a bulky slack-twisted thread of cheap construction, is inserted, all the face-warp ends are raised, as shown by the blue dots, and the backing warp depressed, so that the picks will lie in the center of the fabric without interlacing with either the face or backing warps and without showing on either side of the cloth. By this means the weight and bulk of the goods may be increased very cheaply, and at the same time the appearance of the fabric suffers no deterioration.

A double-cloth weave having the same construction as Fig. 47, except that a wadding warp instead of wadding filling is used, is shown in Fig. 48. This weave is arranged 1 face, 1 back, 1 wadding in the warp and 1 face, 1 back in the filling. The wadding ends are raised over every backing pick, as shown by the blue dots, and depressed under every face pick, so that they lie in the center of the cloth without interlacing, in exactly the same manner that the wadding filling is inserted in Fig. 47. However, it is not possible to use as

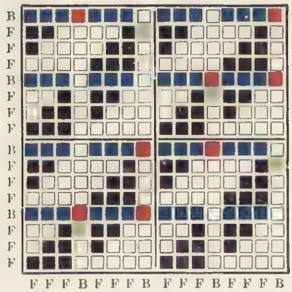


Fig. 41

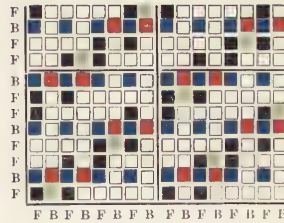


Fig. 42

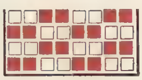


Fig. 43

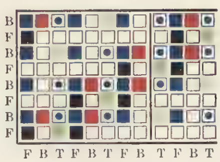


Fig. 46

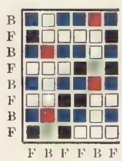


Fig. 44

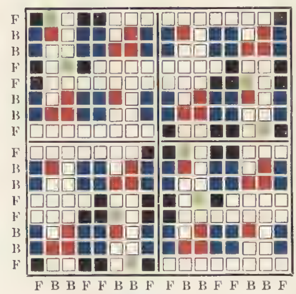


Fig. 45

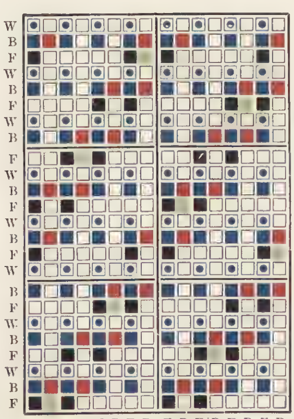


Fig. 47

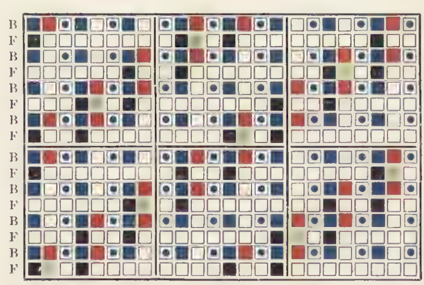


Fig. 48

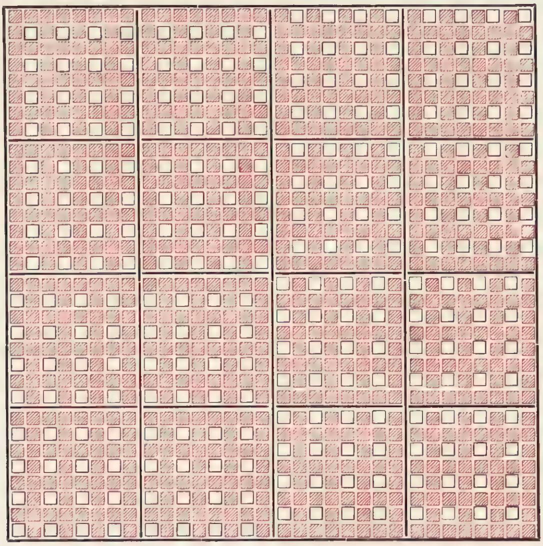


Fig. 49

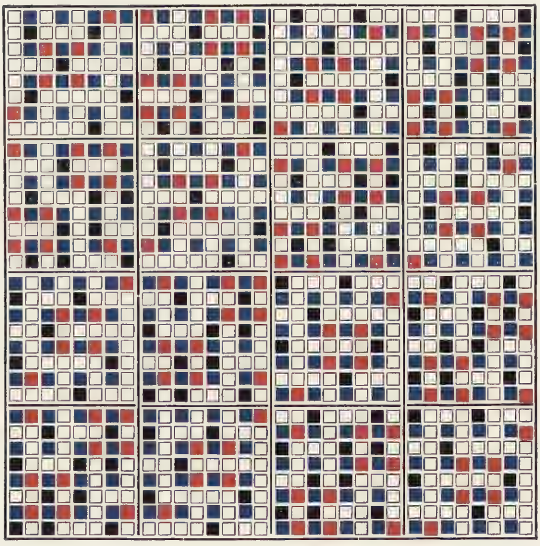


Fig. 50

cheap a grade of yarn for a wadding warp as for a wadding filling since a warp yarn must always possess a certain amount of strength in order to withstand the chafing of the harnesses and reed during the weaving process.

CUT DOUBLE CLOTHS

29. Double-cloth weaves that produce fine indented lines, or *cut marks*, on the surface of the fabric are known as **cut double cloths.** These cut marks may be produced in double-cloth weaves arranged 1 face and 1 back by reversing the weave in either the warp or filling or both, the principle being similar to that employed for producing a cut mark in the filling-backed weave shown in Fig. 16. The cut marks are generally arranged so as to run lengthwise of the fabric or else so as to run both lengthwise and crosswise and produce checks in the fabric. Suppose, for example, that it is desired to produce a cut double-cloth weave in which the cut marks shall run in the direction of both the warp and the filling.

The first step in the production of such a weave is to shade the design paper so as to indicate which are the backing and which are the face ends and picks, at the same time arranging for reversing the weaves to produce the cut marks. Fig. 49 shows the design paper shaded in this manner, the pink-shaded squares indicating the backing ends and picks; it will be noticed that in the first section of 16 ends the odd-numbered picks are the face picks and the even-numbered picks the backing picks, while in the second section of 16 ends the reverse is true. Thus, the first pick of the weave is a face pick for 16 ends and between the sixteenth and seventeenth ends passes to the back of the cloth and becomes a backing pick, while the second pick is a backing pick for the first 16 ends and then passes to the face of the cloth and becomes a face pick. The filling passing to the back and to the face between the sixteenth and seventeenth ends throughout the cloth will produce a fine cut mark the whole length of the piece. In a similar manner, the first end of the weave is a face end for 16 picks and then passes to the back of the cloth and becomes a

backing end for 16 picks, while the second end is a backing end for the first 16 picks and a face end for the next 16 picks, and so on throughout the weave. Thus, it will be seen that the ends, in passing from face to back and back to face between the sixteenth and seventeenth picks, will produce a cut mark running across the fabric.

After the design paper is shaded in this manner, it is simply necessary to place a face weave on the face ends and picks and a backing weave on the backing ends and picks and to raise all the face warp on the backing picks. In Fig. 50 the completed design is shown, the $\frac{2\ \ 1\ \ 1}{\ \ 1\ \ 2\ \ 1}$ regular twill being used for a face weave and the 8-end twill basket for a backing weave. Generally, it is unnecessary to introduce the ordinary double-cloth binding between the face and the back cloths, as the transposing of the face ends and picks and backing ends and picks serves to bind the cloth securely on each cut mark both warp-way and filling-way; but in case the cut marks are arranged so as to form checks of any considerable area, it is advisable to tie the face and backing weaves in each section exactly the same as in an ordinary double cloth, since the pockets formed between the cut marks will otherwise be too large and thus render the fabric somewhat loose in structure.

The cut marks can be made much more prominent by using a cut check weave for the face weave or for both the face and backing weaves and reversing the warps and fillings at the points where the cut of the face or face and backing weaves occurs. By this means, the cut marks that would naturally occur by using a cut check weave in the cloth are greatly accentuated and serve to divide the sections of the check very prominently. Cloths woven with weaves like Fig. 50 are generally woven white and then piece-dyed one solid color, and as both series of yarns appear on the face, both should be of the same quality.

30. When it is desired to produce cut marks in double-cloth weaves arranged with two face threads alternating with one back thread, a somewhat different method is

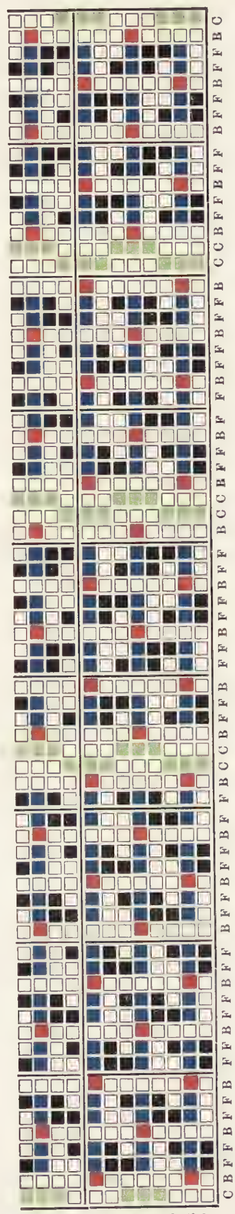


Fig. 51

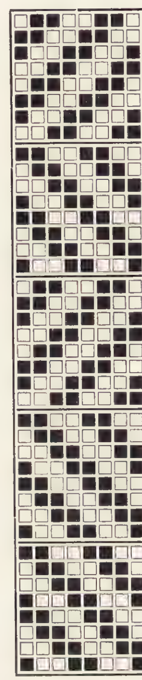


Fig. 52

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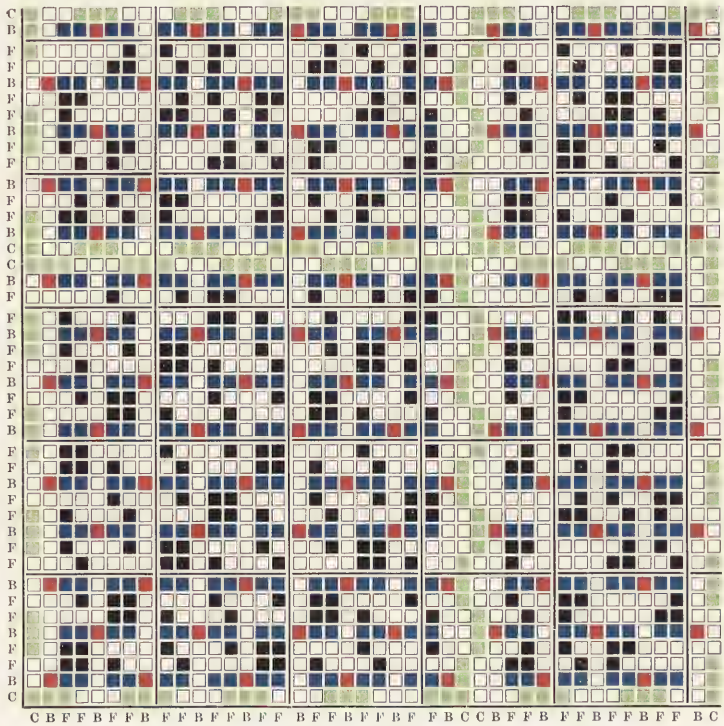

Fig. 53

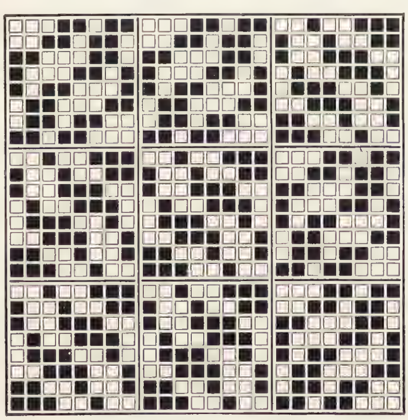

Fig. 54

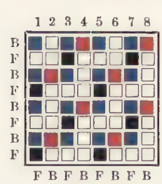

Fig. 55

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employed. In this case, if a cut mark running lengthwise of the goods is desired, 2 ends are inserted in the weave that interlace with both the face and backing filling exactly as in a single-cloth weave; or if a cut mark across the cloth is called for, 2 picks similarly interlaced with both warps are inserted. Fig. 51 is a double-cloth weave with cut marks made by this method, arranged to run lengthwise of the fabric. The face weave in this case is an angled stripe weave made with the cassimere twill as shown in Fig. 52, while the backing is the plain weave. Wherever it is desired to make a cut mark, 2 cutting ends are substituted for 2 face ends, these ends being arranged to interlace alternately $\frac{3}{3}$ with the fillings, as shown by the green squares. Thus, cut marks will be produced between the second and seventy-first, twenty-sixth and twenty-ninth, forty-first and forty-fourth, fifty-sixth and fifty-ninth ends. It will be noticed that the cut marks are so arranged as to coincide with and accentuate the cuts that would naturally occur in the face weave. By arranging a weave with cutting picks, the cut marks may be made to run across the fabric; and by combining both methods, the cut marks may be made to form checks in the fabric. A cut double-cloth weave arranged in this manner is shown in Fig. 53, the face weave being a cut check made with the Mayo weave, as shown in Fig. 54, and the backing weave plain.

DOUBLE PLAIN WEAVES

31. Double plain weaves, although constructed similar to ordinary double-cloth weaves, are never tied by raising the ends or picks of the backing fabric into the face fabric, but always by reversing the positions of the two cloths; that is, by bringing the backing ends and picks to the face and passing the face ends and picks to the back. A double plain fabric consists of two plain cloths, that is, cloths woven with the $\frac{1}{1}$, or plain, weave, arranged so that one cloth is above the other in the loom exactly like an ordinary double cloth.

A weave that will produce this effect is shown in Fig. 55, which is an ordinary double-cloth weave with the plain

weave on the face ends and picks and also with the plain weave placed on the backing ends and picks. The face and back cloths in this weave are not tied together, and so two plain woven cloths will be formed in the loom, one above the other, as shown in Fig. 56. If Fig. 55 were warped and woven 1 black, 1 red, that is, if all the face ends and picks were black and the backing ends and picks red, the face fabric would be black and the back fabric red, as indicated in Fig. 56. By comparing Figs. 55 and 56, it will be seen that this is true, since the first pick (black) floats under the first end, over the second, third and fourth, under the fifth, and over the sixth, seventh and eighth, while on the second pick (red), the filling floats over the fourth and eighth ends and under the first, second, third, fifth, sixth and seventh, etc., the filling alternately interlacing first with one cloth and then the other, each color being always interlaced with its own color of warp.

A section of the weave shown in Fig. 55 is shown in Fig. 57, and indicates the interlacing of the filling with the warp. The ends are numbered from *1* to *8*, the odd numbers being on the face of the cloth and the even numbers on the back. In this case, however, the cloth is not warped and picked 1 black and 1 red, as in Fig. 56, but is all of one color, being woven from one shuttle, so that the two cloths will be tied at each edge, thus producing a tube, or bag, in the loom. In Fig. 57 only 8 ends are shown, but it will be understood that actually there are a large number of ends working like ends *3*, *4*, *5*, and *6*, and that the cloth is bound only on each edge.

If it is desired to produce a cloth that is interwoven at one edge only, and will thus open out to twice its width when taken from the loom, 2 picks should be placed in the face, then 2 picks in the back, instead of 1 face and 1 back. The weave for accomplishing this is shown in Fig. 58, while a section of the fabric is shown in Fig. 59.

32. In order to bind double plain cloths so as to produce a firm double fabric, it would be impractical to raise a

backing warp thread to the face on account of the impossibility of finding a place in the face weave that would cover the tying place perfectly. The system adopted, therefore, for amalgamating the face and back fabrics and at the same time for producing patterns with double plain weaves is to reverse the fabric; that is, to pass the face cloth, warp and filling, through the fabric to the back and the backing yarns to the face.

Double plains are largely used in producing stripe patterns, it being possible by their employment to produce a heavy fabric of fine texture with stripes of solid color on both sides of the cloth. As a rule, the filling yarn should be finer than the warp yarn in this class of fabrics, and there should be more picks than ends per inch. If there are more ends than picks, the lines or stripes of color will not be so perfect or compact. In designing a double plain stripe, the simplest method is to shade the ends 1 face and 1 back, as in the case of double cloth, reversing the weave by bringing 2 back or 2 face ends together. By this means, since the warp is dressed with a thread of one color alternating with a thread of another color, one color of the warp is brought to the face in one portion of the stripe and the other color is brought to the face for the other stripe. The filling interlaces first on the face and then on the back of the cloth, according to which color of warp is on the face or back, each pick of filling always interlacing with its own color.

Fig. 60 shows the design paper shaded for a double plain stripe arranged in the warp 1 face and 1 back for 8 ends and then 1 back and 1 face for 8 ends, in order to reverse the weave as previously explained. The first pick is a face pick for the first section of 8 ends and a backing pick for the next 8 ends, while the second pick is the reverse of the first, so that the filling being picked alternately with different colors will interlace with its own color of warp both on the face and back of the cloth. After the design paper is shaded, it is simply necessary to place the plain weave on both the face and the backing ends and picks and to raise the face warp on the backing picks, as shown by the blue squares,

in order to complete the weave as shown in Fig. 61. If this weave is warped and woven 1 black and 1 red, black and red stripes will be formed on both sides of the cloth, the black stripe on the face covering the red stripe on the back, and vice versa. That this is true may be seen by examining the section of this design given in Fig. 62, which shows the method in which each pick interlaces with the warp. From this section, it will be seen that the black picks, which are put in the cloth alternately, interlace only with the black, or odd-numbered, ends, and the red picks interlace only with the red, or even-numbered, ends. Where the odd- and even-numbered, or the black and red, ends change places at *7*, *8*, *9*, and *10*, the two cloths are tied together. The cloths are also tied together, of course, at the fifteenth, sixteenth, first, and second ends.

33. Double plain fabrics are useful in producing many other varieties of patterns besides stripes. Fig. 63 shows the design paper shaded for a double plain checker-board effect, while Fig. 64 shows the complete weave, the face and back plain weaves being placed on the face and backing ends and picks, respectively, and the face warp raised on the backing picks. If this weave is warped and picked 1 black and 1 red, a reversible checker-board effect consisting of black and red checks on the face and back of the goods will be formed, the black checks on the face covering the red checks on the back of the goods, and vice versa. The weave is bound at the first and thirty-second and the sixteenth and seventeenth ends and picks by reversing the cloths. This will have the effect of forming pockets in the cloth, each check being the extent of the pocket. Double plains are not confined to the simple effects that have been described here, as solid twill lines of color, fancy, or figured effects may be readily obtained, the method being to mark out the desired motive and place the double plain weave on it, then reverse the weave around the outline of the figure, and place the reverse double plain weave on the ground. By this means, a weave may be warped and woven 1 black and 1 red and a red spot

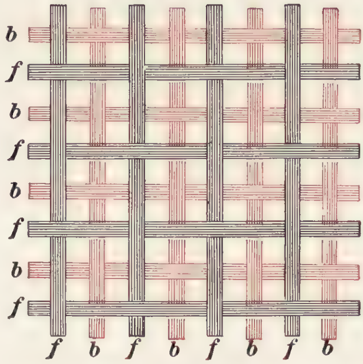


FIG. 56

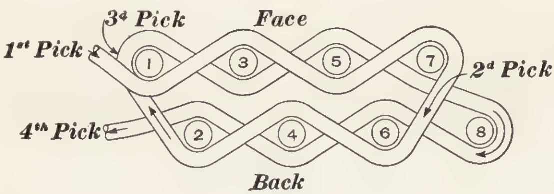


FIG. 57

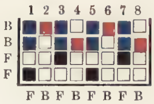


FIG. 58

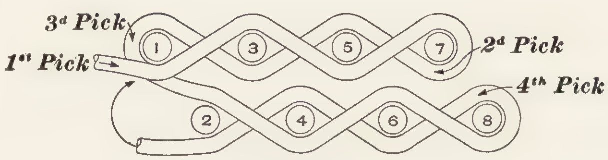


FIG. 59

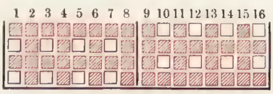


FIG. 60

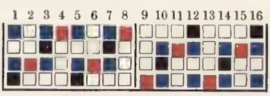


FIG. 61

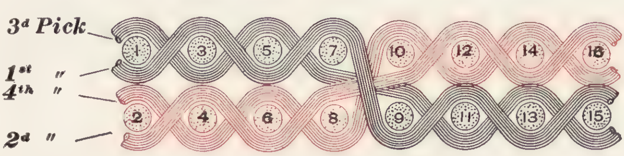


FIG. 62

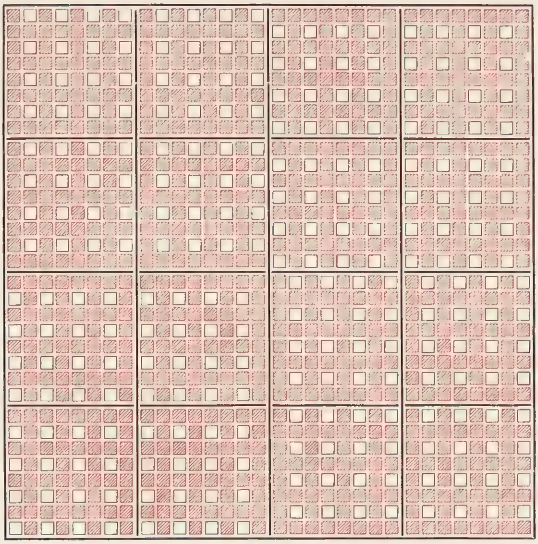


FIG. 63

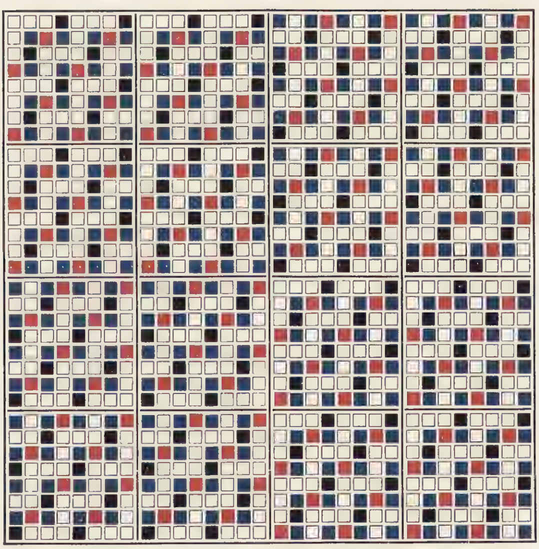


FIG. 64

or figure on a black ground made on the face of the cloth, while the back of the cloth will show a black figure on a red ground.

DRAFTING OF DOUBLE-CLOTH WEAVES

34. In constructing the harness and chain drafts for double-cloth weaves, the same methods are employed as for warp-backed weaves. Double-cloth weaves may, of course, be drafted exactly the same as single-cloth weaves, but for the reasons given, when dealing with warp-backed weaves, it is better to separate the harnesses through which the face and backing warps are drawn, constructing the chain draft in each instance to correspond with the method adopted for drawing in the warps. The following drafts for double-cloth weaves indicate the method employed: Fig. 65 (*a*) is the drawing-in draft and Fig. 65 (*b*) the chain draft for the double-cloth weave shown in Fig. 38, the backing warp being drawn on the front and the face warp on the back harnesses. Fig. 66 (*a*) is the drawing-in draft and Fig. 66 (*b*) the corresponding chain draft for Fig. 40, the face warp in this case being drawn on the front harnesses and the backing warp on the back harnesses.

Reversible weaves in which the warp alternately interlaces on the face and on the back of the fabric are best drafted exactly like single cloths, although double plain weaves are occasionally drafted so that one color will be drawn on the front harnesses and the other on the back harnesses.

EXAMPLES FOR PRACTICE

1. Construct a double-cloth weave arranged 1 face and 1 back in both warp and filling, placing the 8-harness twilled basket on the face and the plain weave on the back and tying the backing weave perfectly to the face in 8-harness satin order. Make harness and chain drafts with the face warp drawn on the front harnesses.

2. Make a double-cloth weave arranged 1 face, 1 back, 1 face in both warp and filling, placing the cassimere weave on the face and the 4-end basket on the back and tying the backing weave perfectly to the face in 8-end satin order. Make harness and chain drafts with the backing weave drawn on the front harnesses.

3. Make a double-cloth weave arranged 1 face and 1 back in the warp and 1 face, 1 back, 1 face in the filling, the face weave to be the $\frac{3}{2}\frac{2}{1}$ regular twill and the backing weave plain. Make two repeats of the face weave in the filling and alternately tie the backing ends to the face weave on the warp-flush twill line. Make harness and chain drafts, the backing weave to be drawn in on the back harnesses.

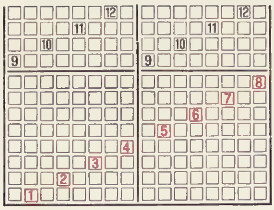
4. Make a double-cloth weave arranged 1 face and 1 back in both warp and filling, the face weave to be the $\frac{4}{1}$ regular twill and the backing weave to be a 5-harness satin showing a filling flush on the back of the cloth. Stitch in regular order and show harness and chain drafts with the face warp drawn in on the front harnesses.

5. Make a double plain weave on 16 ends that if warped and picked 1 black, 1 red will show a black stripe on the face of the cloth three times the width of the red stripe, and vice versa on the back—a red stripe three times the width of the black stripe.

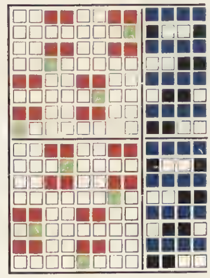
TRIPLE CLOTHS

35. Triple-cloth weaves are used for heavy-weight woolen goods, such as golf capes, cloakings, etc. As the name indicates, a triple cloth is composed of three cloths woven one on top of the other in the loom. These three cloths are known as the *face*, *center*, and *back cloths*. The center cloth is tied to the face cloth and the back cloth to the center cloth, thus uniting all three cloths into a strong heavy-weight fabric. The same laws regarding tying that were laid down when dealing with double cloths are applicable to triple cloths. When binding the back to the center, however, more care should be taken to bind every end regularly than to lay any stress on raising the backing end between two warp floats of the center cloth, since imperfect stitching of this description cannot show on the face of the goods. Wherever possible the back cloth should also be tied to the center cloth so that the tying points will be covered on the back of the cloth.

When laying out triple-cloth weaves, it is always better to use some loose weave for the center cloth, since this cloth does not affect the appearance of the goods, but simply adds weight. Satin weaves are especially appropriate to use in this connection. The first step when making a triple-cloth

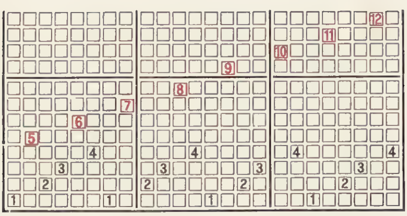


(a)

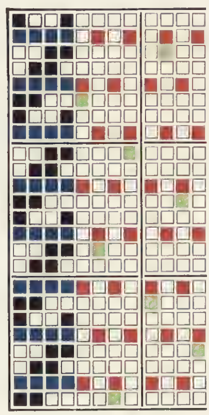


(b)

FIG. 65



(a)



(b)

FIG. 66

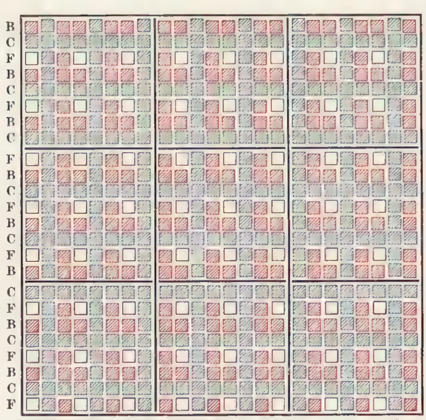


FIG. 67

weave is to shade the design paper, and for this purpose two differently colored pencils may be used, one to shade the center ends and picks and the other to shade the backing ends and picks. As more familiarity with the construction of both double and triple cloths is obtained, it will be possible to construct the simpler weaves without shading the ends and picks, but for the beginner, or with complicated and large designs, shading is to be preferred, as it eliminates the possibility of error.

To illustrate the construction of a triple-cloth weave, suppose that it is desired to make a weave having the cassimere twill on the face, the center cloth to be an 8-end satin, and the back of the fabric to show the 4-harness basket weave. The center cloth is to be bound to the face cloth and the back to the center in 8-end satin order, the weave to be arranged 1 face, 1 center, 1 back, in both warp and filling.

The first step is to shade the center and backing ends and picks with differently colored pencils after the manner shown in Fig. 67, in which the light-blue-shaded squares represent the center ends and picks, and the pink-shaded squares the backing ends and picks. The next process is to place the face, center, and backing weaves on their respective ends and picks, as shown in Fig. 68, where the face weave is shown in black, the center weave by the blue marks, and the backing weave by the red-filled squares. After placing the weaves on the design paper, the cloths are tied by raising the center ends over the face picks, arranging the binding points in 8-end satin order and so that the center end will be raised between two face warp floats. This binds the center to the face, but does not bind the back cloth, this latter being accomplished by raising the backing warp ends over the center picks in a similar manner. After the separate cloths are tied together, the next step is to raise each face end over the center and backing picks and each center end over the backing picks, in order that each filling may interlace with its own warp. The completed triple-cloth weave with each of the above points worked out is shown in Fig. 69, where it will be noticed that the binding of both the center to the

face and the back to the center cloth is accomplished in satin order. In this design, the black squares represent the face weave; the blue squares, the center weave; and the red squares, the backing weave. The green squares show the method of stitching the center to the face, and the green dots indicate the tying of the back to the center cloth. The black-shaded squares indicate the face warp raised over the backing and center picks, while the light-blue-shaded squares indicate the center warp raised over the backing picks.

DRAFTING

36. When making the drafts for triple-cloth weaves, it is always better to separate the face, center, and backing ends, as by this means the harness draft is simplified for the weaver. The method of procedure in drafting is the same as that employed for double cloths, except that three separations are made instead of two. Fig. 70 (*a*) shows the harness draft for Fig. 69 with the face ends drawn in on the first 4 harnesses, the center on the next 8, and the back on the last 8 harnesses. The chain draft for Fig. 69, according to the drawing-in draft in Fig. 70 (*a*), is shown in Fig. 70 (*b*).

EXAMPLES FOR PRACTICE

1. Make a double plain stripe weave complete on 8 ends and 4 picks, which, if dressed and woven 1 red and 1 black, will produce red and black stripes on each side of the cloth.

2. Make a triple-cloth weave, the face to be the $\frac{3}{1}$ regular twill, the center weave the 8-harness satin, and the backing weave the cassimere twill. Tie the center to the face and the back to the center in 8-harness satin order. The design is to be arranged 1 face, 1 center, and 1 back. Give harness and chain drafts.

3. Make a double plain weave for a stripe, the face of the cloth to show 8 red ends, 4 black, 8 red, and 2 black.

4. Make an original triple-cloth design.

5. Make a double plain checker-board weave on 24 ends and picks, that if dressed and woven 1 black and 1 white, will show solid checks of black and white on each side of the cloth.

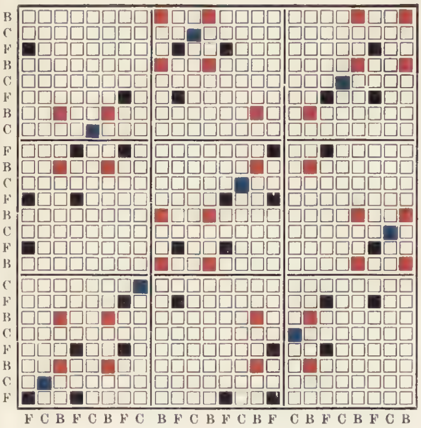


FIG. 68

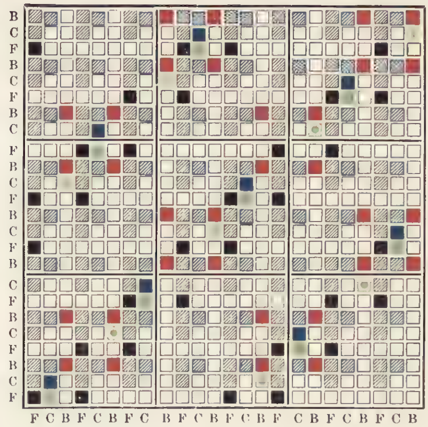
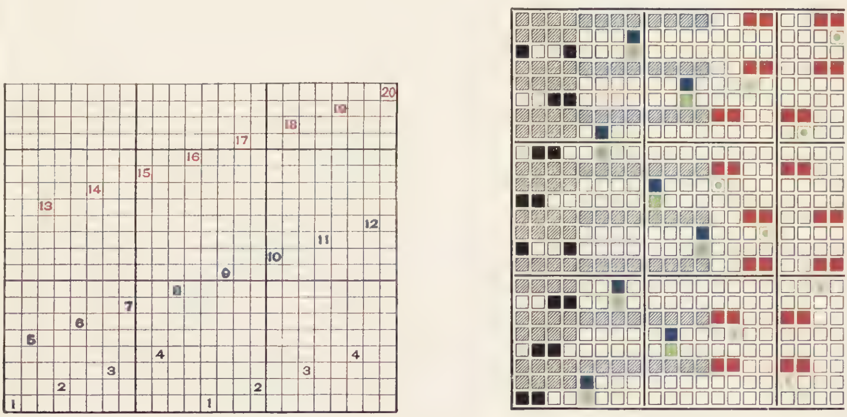


FIG. 69



(a)

(b)

FIG. 70

LENO WEAVES

PLAIN GAUZE

INTRODUCTION

1. Leno weaves is the general term applied to all classes of weaves of a peculiar structure in which some of the warp ends do not lie parallel with, but are twisted partly around, other ends. This principle of interweaving is called **leno weaving, or cross-weaving,** and admits of a great number of variations and combinations in developing ornamental effects decidedly different from those produced by the ordinary method of fancy weaving. As every leno weave is what is termed the *plain gauze* weave, or some variation or enlargement of it, or a combination of an ordinary weave with it, known as *fancy gauze*, the subject of leno weaves is best treated in its natural divisions—plain gauze and fancy gauze.

FIG 1

2. A **plain, or pure, gauze fabric,** as represented in Fig. 1, is one in which an end of the warp is raised on one side of an adjacent end on one pick and raised on the other

side of the same end on the next pick. Thus in Fig. 1, the end a, which is known as the **doup end,** is raised over the first pick on the left of the end a_1, which is called the **ground end;** but on the second pick, a is raised on the right of a_1. It will also be noted that the doup end a is raised and the ground end a_1 depressed on every pick, the formation of the cloth being made possible by the doup end crossing the ground end between the picks. The weave is complete on 2 picks, as the succeeding picks are merely repetitions of the picks described. Two ends only are required for the completion of this weave, since the entire warp is composed of pairs of ends, each pair working similarly to the 2 ends described. Thus throughout the width of the warp the doup ends are raised over every pick inserted, first on one side and then on the other side of the ground ends around which they twist. Between the picks, each doup end crosses under the ground end with which it works.

This method of interlacing results in several features peculiar to leno weaves. Since the ends of the warp cross each other and more room is usually allowed them than if they were parallel in the cloth, an openwork effect is produced. This open effect is often increased by leaving more space between the pairs of ends than is actually required for their proper working; this is done by leaving certain dents of the reed empty. Since the crossing of the ends prevents the beating up of the filling as close as in ordinary cloths, the openness of leno fabrics is still further increased.

The crossing of the warp yarn binds the warp and filling very firmly together, so that the plain gauze weave makes the strongest cloth that can be woven with a given weight of yarn. A gauze fabric may thus have an open, or lace-like, appearance, be light in weight, and yet possess sufficient strength to wear well.

A peculiar zigzag effect, due to the twisting of the ends, is also characteristic of leno fabrics, but this effect is much more noticeable in fancy gauze than in plain gauze weaves for reasons that will be obvious as these weaves are studied in detail.

PLAIN GAUZE ON CLOSE-SHED LOOMS

BOTTOM DOUPS

3. The majority of gauze fabrics are woven on dobby looms, of either the *close-shed* or *open-shed* type. The terms close-shed dobby and open-shed dobby are practically synonymous with the terms single-lift dobby and double-lift dobby so frequently used in the cotton-mill industry. There is some confusion as to the exact meaning of these latter terms, but the consensus of opinion is that a single-lift dobby is one with but one lifting knife, or bar, while a double-lift dobby is equipped with two knives. Single-lift dobbies form a close shed, while double-lift dobbies, such as are ordinarily used in cotton mills, generally form open sheds. A close-shed dobby is therefore usually understood to be a single-lift dobby, while the term open-shed dobby generally infers a double-lift dobby.

FIG. 2

4. Harnesses.—The crossing of the ends in weaving plain gauze requires extra harnesses, so that 4 harnesses are necessary, as well as special mechanisms, to control the warp yarn. Two of the harnesses are of the usual type, but in gauze weaving they are called the *ground* and the *back harnesses*. The other harnesses are of peculiar construction and are called the *standard* and the *doup harnesses*.

The **standard harness**, shown in Fig. 2, is like an ordinary harness with the exception that each heddle has two eyes instead of one. Sometimes heddles are used that have eyes

of the same size, but heddles with the upper eye, in the case of bottom doups, considerably larger than the lower are often used on the standard harness. A standard heddle that has one eye larger than the other will not chafe the doup so much as when both eyes are of small size.

The **doup harness,** shown in Fig. 3, consists of a frame similar to that of an ordinary harness, to the lower part of which are attached worsted, cotton, or linen loops, called **doups—bottom doups** in this case, because they are

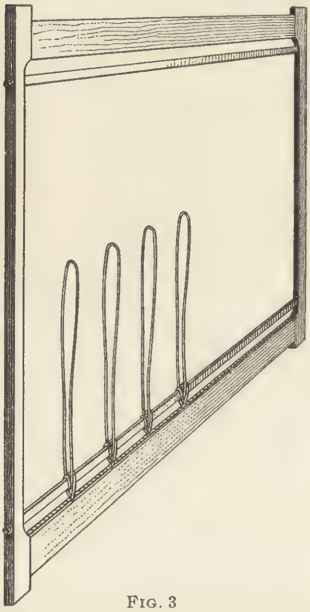


Fig. 3

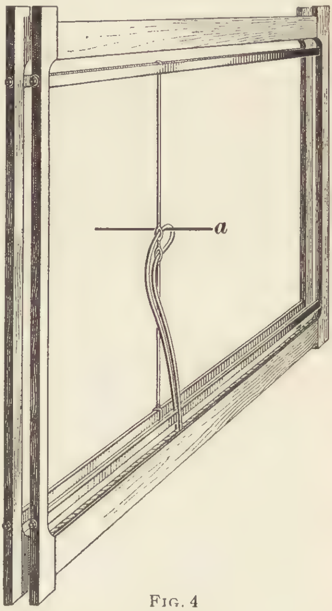


Fig. 4

attached to the lower part of the harness frame. Worsted yarn is preferred for this purpose on account of its elasticity and superior wearing qualities. Heddles are not used on the doup harness. In order to provide for crossing the doup and ground ends in weaving, it is necessary to combine the doup and the standard harnesses in the manner shown in Fig. 4. In attaching the doup harness to the standard harness one end of the doup is fastened to a cord stretched tightly across the lower part of the doup-harness frame;

the other end is passed around the heddle bar, through one eye of the standard heddle, back through the other eye, and, after being passed around the heddle bar again, is fastened to the cord beside the first end. It is not essential that the cord be placed in the exact position shown in Fig. 3. It may be higher up and nearer to the heddle bar, or it may be about $\frac{1}{4}$ inch above the heddle bar; in fact, the latter is the position preferred by many. It is secured on each side either by being passed through holes in the side piece of the harness frame and tied there, or by being attached to hooks fixed on the inside of each side piece of the harness frame. Sometimes the doups are merely fastened to the heddle bar and no cord is used. In Fig. 3, the proper method of passing the doups around the heddle bar of the doup-harness frame is shown; in Fig. 4, and other figures, the doup is simply indicated as being attached to the cord. No ends are drawn through the standard heddle, but the doup end is drawn through the loop formed by the doup passing through the eyes of the standard heddle. If the loop is on the right of the standard heddle, as in Fig. 4, it is a *right-hand doup;* if on the left, it is a *left-hand doup.*

5. The Slackener.—The normal position of the doup end is on one side of the ground end, but on every alternate pick it is crossed under the ground end and raised on the opposite side. Whenever this crossing takes place, an additional strain would be brought on the doup ends if some arrangement were not provided to compensate for the extra length of warp yarn required by the crossing action of the doup ends. To obviate this difficulty a mechanism, called the **slackener, easing bar,** or **easer,** is applied to the loom, the object being, as previously intimated, to give a little slack to the doup ends when they are raised out of their normal position. This arrangement is shown in Fig 5; d is a rod extending the width of the loom, attached at one side to an arm d_3 and at the other side to a similar arm. These arms are fastened to a rod d_2, to the end of which nearest the dobby another arm d_1 is fastened. The arm d_1 is connected

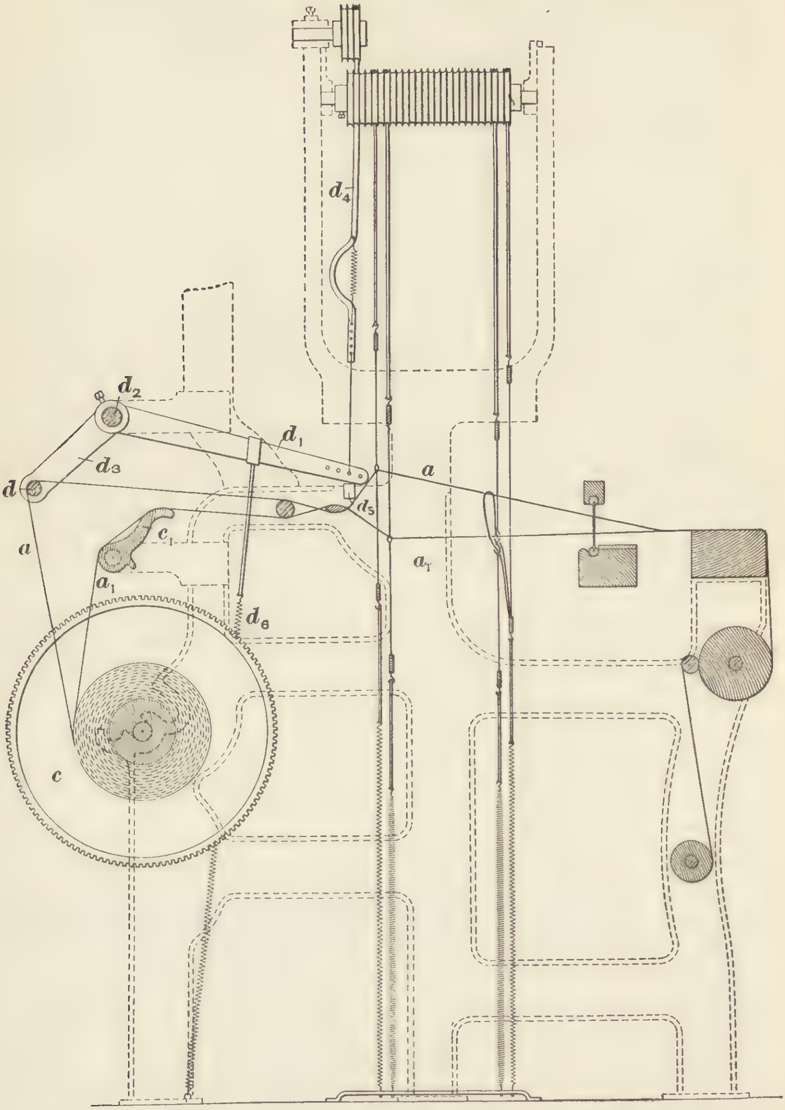


FIG. 5

by a strap d_4, which passes over a separate sheave attached to the arch of the loom, as shown in Fig. 5, to one of the harness levers of the dobby. This lever is usually the one farthest from the fell of the cloth and is operated in the ordinary manner by the dobby. The warp in weaving a plain gauze is usually wound on one beam c, and the ground ends a_1 passed over the whip roll c_1 in the ordinary manner. The doup ends a, however, are passed over the bar d of the slackener; thus whenever the doup ends are required to cross the ground ends and be raised out of their normal position, they may be slackened by placing a peg in the harness chain so as to raise the lever that operates the slackener. When this lever is raised, the bar d will be drawn in so as to give the required slack to the doup ends; this is necessary on every alternate pick of a plain gauze weave.

6. Arrangement of Harnesses and Ends.—The crossing of the doup and ground ends in weaving necessitates a peculiar arrangement of the harnesses and the ends controlled by them. The 4 harnesses already mentioned are arranged in the following order, beginning at the front: doup harness, standard harness (through the heddles of which the doups pass), ground harness, and back harness. The ground and the back harnesses are usually placed as far back as possible, so as to put the least possible strain on the doup ends when the crossing takes place. In the European method of weaving lenos, the relative position of the last 2 harnesses is reversed; but they are operated in the same manner as in the American system to obtain like results.

Fig. 6 shows the arrangement of the harnesses and the method of drawing in the doup and ground ends. The doup end a is first drawn over the slackener rod d, Fig. 5, and through the back harness and doup, as shown in Fig. 6. Although this end is usually called the doup end, it is also called the *douping end*, *crossing end*, or *whip end*. The ground end a_1 is drawn in the usual manner over the whip roll and through the ground harness, but is then crossed over the doup end; it is then drawn in the same dent in the reed as the

doup end. This reeding is absolutely necessary in order to allow the ends to cross in front of the reed. If the ground end and the doup end were not drawn through the same dent of the reed, whenever the doup end crossed the ground end the split of the reed would prevent the crossing from passing forwards; and in consequence, no shed could be formed in front of the reed. This would take place on every alternate pick in the case of plain gauze. It must be understood that

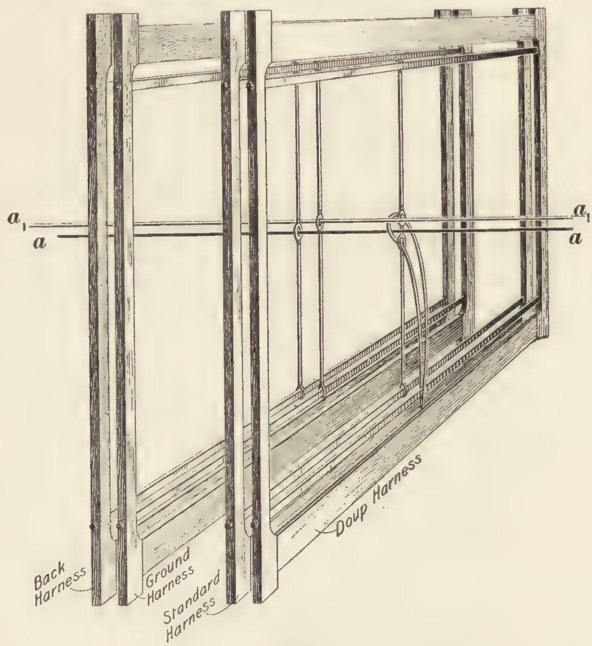


FIG. 6

in plain gauze every alternate end throughout the body of the warp is a doup end drawn in like a, and that the other ends are ground ends drawn in like a_1, though for convenience of explanation only 2 ends are shown.

7. Operation of Harnesses.—The operation of the harnesses when a plain gauze fabric is being woven on a close-shed loom, will now be considered. It has been noted in Fig. 1 that the doup end a is raised on every pick, but on

successive picks is on opposite sides of the ground end. On the first pick, the doup end is raised on the left of the ground end and passes straight from the back harness to the fell of the cloth, as shown in Fig. 7. On this pick the ground harness remains down, as does also the standard harness; the back harness is raised, in order to lift the doup end, and the doup harness must also be lifted, so that the doup end

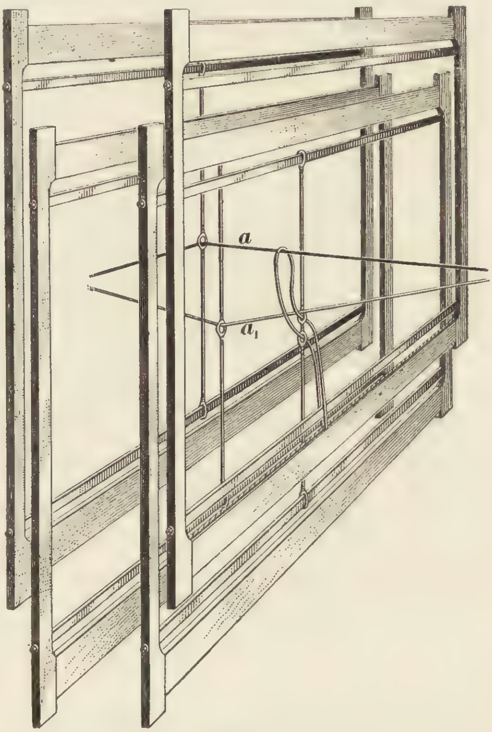


Fig. 7

in rising may pull the doup through the eyes of the standard heddle. If the doup harness were not raised, the back harness could not raise the doup ends, as the doups would hold them down. After the pick has been inserted in the shed, the harnesses are returned to the bottom of the shed, as shown in Fig. 6. On the second pick the doup end is raised on the right of the ground end, which it crosses in forming

the shed, as shown in Fig. 8. The doup end is raised on this pick by lifting both the doup and standard harnesses, which act as one. As the ground harness is down, the back harness must also be down to avoid straining the doup end, since the doup end crosses the ground end directly in front of the ground harness.

It is evident that when this crossing of the ends takes place and the shed is formed wholly in front of the ground

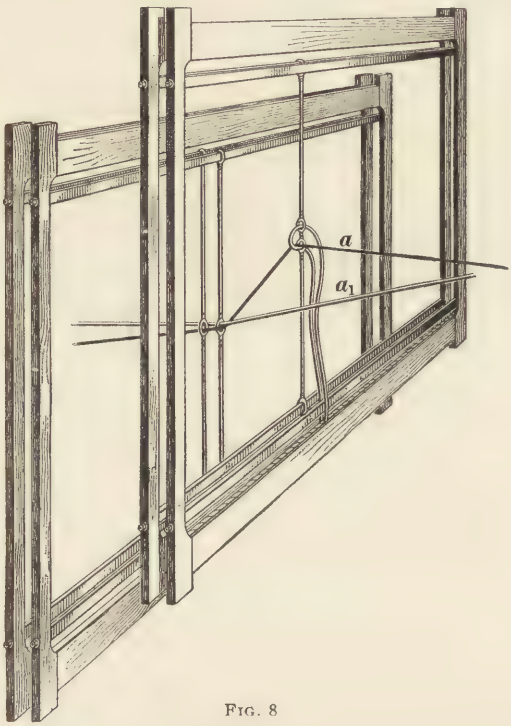


FIG. 8

harness, there is considerable strain on the doup end. The slackener, shown in Fig. 5, is designed to relieve the tension of the doup ends, which are drawn over it, by moving the rod *d* forwards as the crossing takes place. This second pick completes one repeat of the weave, and after it has been inserted the doup and standard harnesses, as well as the lever of the dobby that operates the slackener,

are lowered and all the harnesses are level at the bottom of the shed, as shown in Fig. 6, ready for another repeat of the weave.

In summarizing the operation of weaving plain gauze on a close-shed dobby, it may be said that the ground harness is never raised and that on one pick the doup and back harnesses are raised, while on the next pick the doup and standard harnesses are raised and the slackener is operated.

8. A careful study of Figs. 6, 7, and 8 will show that the several harnesses and the slackener must be operated as described, in order to form properly the sheds required in weaving plain gauze without putting undue strain on the yarn and the doups. The positions of some of the harnesses might be changed and plain gauze could still be woven, but these changes would be of no particular advantage and would involve several disadvantages. As has already been stated, in the European method the ground ends are drawn through the last harness and the doup end through the next to the last harness. The ends controlled by these harnesses, however, are operated in the manner described, and there is practically no choice between the convenience and effectiveness of the two systems.. The doup and standard harnesses could be reversed in position, but there would be no advantage in this arrangement, and broken doups could not as easily be replaced.

9. When the crossing of the doup and ground ends occurs, it is desirable, in order to put the least strain on the ends, to reduce as far as possible the angle formed by the ends in front of the point of their intersection, which is just in front of the heddle eye through which the ground end is drawn. This object is accomplished by placing the ground and back harnesses as far back in the loom as possible, and the doup and standard harnesses at the front. In weaving plain gauze, the available harnesses between the doup and standard harnesses at the front and the ground and back harnesses at the rear are not used at all. When the plain gauze weave is combined with a plain or a fancy weave in

the production of fancy gauze, or leno, fabrics, as explained later, the ends required for the ordinary weave are drawn on the inner harnesses between those that are required at the front and back for weaving the gauze.

10. The doup harness is so constructed that when it is lifted it lifts only the bottom of the doup, while the doup itself must be lifted from the top either by the doup end, when it is raised by the back harness on one side of the ground end, the standard harness being down and the doup sliding loosely through the eyes of the standard heddle, or by the standard harness, when it raises the doup end on the other side of the ground end. If the standard harness is raised, in order to raise the doup end, and the doup harness is not lifted, the entire weight of the doup harness must be sustained by the doups; thus they will be strained or worn out very quickly. On the other hand, if the back harness is raised without raising the doup harness, the doups will hold down the doup ends, thus preventing the formation of a shed and producing considerable strain on the doups and the doup ends. This difficulty, however, is obviated if the doup harness is raised when the back harness is raised, since the only strain on the doups is, in this case, their own weight and a slight amount of friction, which is unavoidable. In view of these facts, it is evident that in weaving plain gauze it is necessary to raise the doup harness on every pick, since the standard harness must be raised on one pick and the back harness on the next pick.

Another important matter connected with the doup and its operation is the relative position of the loop and the standard heddle. In order that the standard and doup harnesses may work properly in weaving plain gauze, it is necessary to have the loop of the doup on the same side of the standard heddle that the ground end is drawn. Thus in Fig. 6, the ground end is drawn at the left of the standard heddle, and the doup end, drawn through the back harness at the left of the ground harness, passes under the ground end through a left-hand doup. If the doup and ground ends were drawn at

the right of the standard heddle, a right-hand doup would be required.

11. Methods of Representing the Weave, and Harness and Chain Drafts.—The study of gauze weaving brings up for the consideration of the designer several points that are not involved in the weaving of ordinary fabrics. Among the most important of these are the representations on paper of the weave and the harness and chain drafts. In a fabric woven in the ordinary manner, each end of the warp is drawn through one harness only and is drawn straight from the beam through the harness to the reed. So far as the weave itself is concerned, the number of harnesses used is the same as the number of ends in the warp that have different interlacings, and the chain draft shows the operation of each harness. In gauze fabrics, the ground ends are drawn through one harness of the ordinary type, while the doup ends are drawn through an ordinary harness at the back, crossed under the ground ends, and also drawn through the doups, which are controlled by both the standard and doup harnesses at the front. Thus in weaving plain gauze, twice as many harnesses are required as there are ends that work differently.

In order to show clearly the method of drawing in the doup and ground ends and their operation, a special system of representing the harness and chain drafts must be used. In making the harness and chain drafts it is necessary to keep in mind which are the doup ends and which are the ground ends. When looking at the surface of a plain gauze fabric that is up in the loom, the doup end is the one that is raised on every pick, but on successive picks is raised on opposite sides of the ground end, which is depressed on every pick.

12. The Weave.—The representation on paper of a gauze weave does not follow the rules that apply to the representation of the weaves of ordinary fabrics. The ordinary method makes use of design paper divided into squares by vertical and horizontal lines. A vertical row of squares is

used to show the interweaving of a warp end and a horizontal row shows a pick of filling. Thus each square represents the intersection of an end and a pick. If the square is marked, it indicates that the end is raised over the pick; if it is blank, it indicates that the end is depressed and the filling floats over it at that point.

This method of representation cannot be applied to the weave in gauze fabrics. The first pick of a plain gauze weave, shown in Fig. 1, may be represented in accord with the principles of this method, since there would be a mark on each alternate end, showing that the first, third, fifth, and seventh ends were raised above the filling and the second, fourth, sixth, and eighth ends depressed, just as in the representation of an ordinary plain weave. The second pick, however, presents several difficulties, since the first end is found to have changed its place and to have assumed a

Fig. 9

Fig. 10

Fig. 11

position that in the plain fabric would have been occupied by the second end, which has also changed position and assumed the place of the first end. If this change in the positions of the ends is ignored and the interlacing of the ends is marked on design paper in the ordinary way, the result will be a series of black marks in one vertical row and blanks in the next vertical row, as shown in Fig. 9. This will show one-half of the warp ends raised and the other half depressed on every pick, in which case there will be no interlacing of warp and filling, and hence no production of a fabric. If the change in the position of the ends is taken into account, but the crossing itself is ignored and the ends are marked according to their position in the cloth, the result will be that shown in Fig. 10; this gives the impression that the fabric is an ordinary plain cloth, which is obviously incorrect.

13. Two methods of representing gauze weaves on paper suggest themselves. The first is to use design paper, but to

adopt different marks to indicate different positions of the ends. Since the ground ends are never raised, the squares showing the working of these ends are left blank. Two marks should be used to indicate the working of the doup ends, one mark, a filled-in square, for instance, for the raising of the end on one side of the ground end in its normal position, and the other mark, a dot, for the raising of the end on the other side of the ground end in its crossed position. According to this method, the weave shown in Fig. 1 would be represented on design paper as shown in Fig. 11. On the first pick, the first, or doup, end is shown raised in its normal position, in this case on the left-hand side of the ground end, and the next end, which is the ground end, is shown depressed, as indicated by the blank; the other pairs of ends are repeats of the first and second ends. On the second pick, the crossing end is raised, but as this is shown by a dot instead of a filled square, it indicates that the doup end is raised on the opposite, or right-hand, side of the ground end after the crossing has been completed. The second, or ground end, is shown depressed by means of a blank, as on the first pick. The other pairs of ends are repetitions of the first and second ends, and the third and fourth picks are repetitions of the first and second picks, since the plain gauze weave is complete on 2 ends and 2 picks.

The system just described is not one that gives at first glance a clear conception of the fabric represented, as it requires a little study before the observer can correctly picture the fabric in his mind. It may be made more clear by the use of color; for instance, by using marks of different colors to represent the raising of the crossing end in different positions; but even these markings are not satisfactory, and this system is therefore not commonly used.

14. The other method of representing a gauze weave on design paper is a diagrammatic one. A typical representation of such weaves that would be entirely satisfactory and could not possibly lead to error or misinterpretation would be to make a sketch or drawing of the ends and picks

composing the fabric, showing their relative positions to one another at every pick and the crossing between the picks; but this would require too much time and practice and some knowledge of freehand drawing. A system, therefore, in common use is a modified system of sketching the cloth, representing it by a diagram. In this case, lines are ruled on a piece of paper, as shown in Fig. 12 (*a*) dividing it into equal-sized squares. Each vertical line represents a ground end, and each horizontal line, a pick of filling. This differs from the regular use of design paper, where the rows of squares, or the spaces between the lines, represent ends and picks, respectively. In this system some method must be adopted to indicate when an end is up and when it is down. Therefore, at each point representing the intersection of

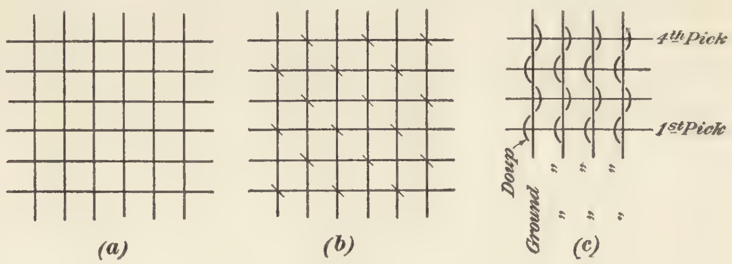


FIG 12

warp and filling, a short, oblique mark is made where the warp is raised over the filling, and no mark where the filling is over the warp. By such a system an ordinary plain weave (not a plain gauze weave) would be shown as in Fig. 12 (*b*). A plain gauze cloth, as shown in Fig. 1, is shown on paper by this system in Fig. 12 (*c*). Curved marks, either in black ink or colored ink, are made to indicate the crossing of the doup end and show on which picks it is raised on the right of the ground end and on which picks it is raised at the left of the same end, as will be seen by comparison with Fig. 1.

15. Harness Draft.—The majority of gauze fabrics are woven on dobby looms, but simple leno weaves may be made on cam-looms, although this is seldom if ever done. Whether cams or dobbies are used, it is necessary to adopt

a system of representing the method by which the ends are drawn through the harnesses, so that when prepared by the designer it may be intelligible to the person who must draw in the ends.

In making a harness draft for a gauze fabric it is necessary to keep in mind the construction and arrangement of the harnesses and the method of drawing in the ends, since these differ radically from the arrangement of harnesses and method of drawing in employed in weaving fabrics of the ordinary construction. It is customary when indicating the drawing-in draft of a gauze, or leno, fabric to make a diagrammatic sketch, ruling horizontal lines to represent the

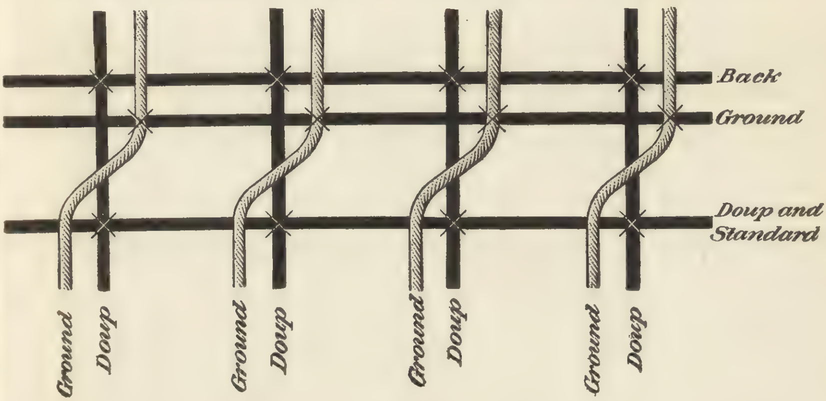


Fig. 13

harnesses, vertical lines to represent the doup ends, and curved lines to represent the ground ends, marking with a small cross where each end is drawn through its respective harness. Such a harness draft is shown in Fig. 13, the horizontal lines, representing the harnesses, being marked with the names *Back*, *Ground*, and *Doup and Standard;* the ends drawn through each harness are indicated as explained, as is also the position of the doup end with relation to the ground end. This draft shows the drawing in of the 8 ends represented in Fig. 1, with the harnesses arranged as in Fig. 6. In Fig. 13, it will be noticed that the doup and standard

harnesses are shown as 1 harness. This is because the doup end passes through the loop that is formed by the doup passing through the eyes of the standard heddle. So far as position is concerned, the doup and standard harnesses may be considered as one when drawing in the ends, but it must be kept in mind that no end is drawn through either eye of the standard heddle.

There are numerous modifications of the draft shown in Fig. 13 in use in different mills, one of them being like Fig. 13 with the exception that the doup and standard harnesses are shown separate. A very common method of representing the harness draft is similar to that shown in Fig. 13, with the exception that the doup end is shown by a curved line and the ground end by a straight line. In another system, the draft is marked on design paper, with each horizontal row of squares denoting a harness and each vertical row representing an end, as shown in Fig. 14, which gives a draft of the same ends as those shown in Fig. 13, the doup and the ground ends being drawn through the twelfth and eleventh harnesses, respectively, the doup ends also passing through the doups connected with the second, or standard, harness, as indicated by the short oblique lines. In Fig. 14 it will be noticed that 8 harnesses have been skipped, in order to allow room between the standard and ground harnesses for the crossing of the ends to take place. The manner in which the doup and ground ends that work together are reeded is so well understood by the person who draws in the ends that the reeding is not always indicated. If, however, it is indicated, the ordinary method of enclosing, by marks placed below the harness draft, those ends that are reeded in the same dent is usually employed. If any dents are skipped between the pairs of doup and ground ends, in order to produce a more open effect, they are indicated in the

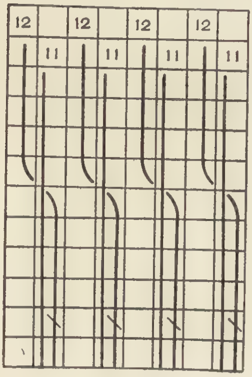


Fig. 14

ordinary manner by the reed draft at the bottom of the harness draft.

16. The **chain draft** for a gauze weave is shown, in the same manner as other chain drafts, by means of design paper on which the vertical rows of squares represent the harnesses, and the horizontal rows, the picks, or bars, of the harness chain. A marked, or filled-in, square shows that the harness represented by the vertical row of squares in which it is placed is raised over the pick represented by the horizontal row of squares in which it is placed. Three columns must be reserved to indicate the working of the 3 harnesses required to manipulate the doup end; also one column for the ground harness; and one column for the harness lever that works the slackener. The standard and doup harnesses each require a vertical row of squares to show their operation.

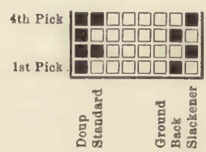


FIG. 15

With Fig. 13 for the harness draft, the gauze weave shown in Fig. 1 is produced by the chain draft shown in Fig. 15. In Figs. 13 and 15, the number of harnesses skipped to allow for the proper crossing of the ends is not definitely indicated, since this varies and does not affect in any way the drawing in and operation of the ends. It will be well to keep in mind the fact that, although the harness and chain drafts show the working of 8 ends for 4 picks, the weave itself is complete on 2 ends and 2 picks.

TOP DOUPS

17. While all the explanations given have referred to the production of plain gauze by means of bottom doups, it is also possible to produce plain gauze on a close-shed dobby by using **top doups,** or doups that are attached to the upper part of the doup harness. Top doups have certain advantages and disadvantages in weaving leno fabrics on open-shed dobbies, which will be considered later in their proper place.

So far as the weave itself is concerned, there is no face or back to a plain gauze fabric, since both sides appear alike.

The interlacing of the doup end when one side of the cloth is viewed is the same as that of the ground end when the other side is examined. As the interlacings are the same, the deflection of the doup and ground ends from a straight line is equal. Therefore, a study of the use of top doups will show that although in weaving the cloth in the loom the relative positions of the doup and the ground ends are reversed, the product will be a cloth that when turned over will show the same interlacings of both the doup and ground ends as in the cloth woven with bottom doups. In the fabric woven with top doups, the same similarity in appearance of the two sides will be noticed as was observed in the fabric woven with bottom doups. It is thus apparent that it is impossible to tell from a sample of a pure gauze fabric whether it was woven with top or botton doups, or right- or left-hand doups; these particulars can only be told when it is known which side of the fabric was uppermost in the loom and which end is the doup end.

18. Construction and Arrangement of Harnesses. The same number of harnesses is required in weaving a plain gauze fabric with top doups as is required for weaving it with bottom doups. The ground and back harnesses are of the ordinary construction. The standard harness, if it carries heddles having both eyes of the same size, is also the same as when used in connection with bottom doups, but if, as is sometimes the case, it carries heddles having eyes of unequal size, these are reversed, so that the large eye is the lower, and their action in conjunction with the top doup, therefore, will be the same as when used with the large eye uppermost, as with bottom doups. The doup harness is constructed the same as when used with a bottom doup, with the exception that the doup is attached to the top of the harness frame instead of to the bottom. The doup and standard harnesses are connected by carrying one end of the doup through one eye of the standard heddle, then back through the other, and fastening both ends of the loop at the top of the doup-harness frame. When top doups are under consideration, a left-hand

doup is one in which the loop of the doup is at the left of the standard heddle, and a right-hand doup, one in which the loop is at the right of the standard heddle, exactly the same as in the case of bottom doups. The harnesses are arranged in the same order as already described for bottom doups—the doup harness at the front of the loom, the standard harness next, then the ground harness, and finally the back harness at the rear. The construction and arrangement of harnesses just described is shown in Fig. 16.

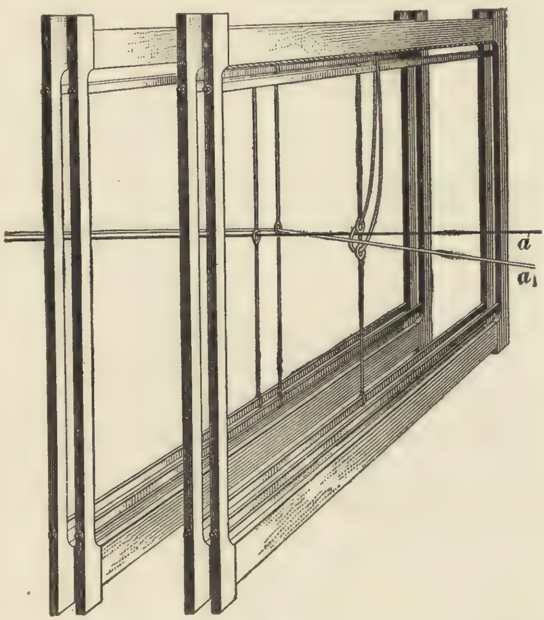


FIG. 16

The doup and ground ends are drawn through the harnesses when top doups are used in exactly the same manner as when bottom doups are employed, with the one exception that when top doups are used, the ground end must be crossed under the doup end instead of over it, as is the case with bottom doups.

19. Operation of Harnesses.—An understanding of the operation of the harnesses when weaving plain gauze with

bottom doups will enable one to comprehend readily their operation when producing the same cloth with top doups. When top doups are used to weave gauze, the doup end remains down and the ground end is raised on every pick.

If the doup end *a*, Fig. 16, is to be depressed under the first pick on the left of the ground end a_1, it is necessary that the back harness and the doup harness be left down, the

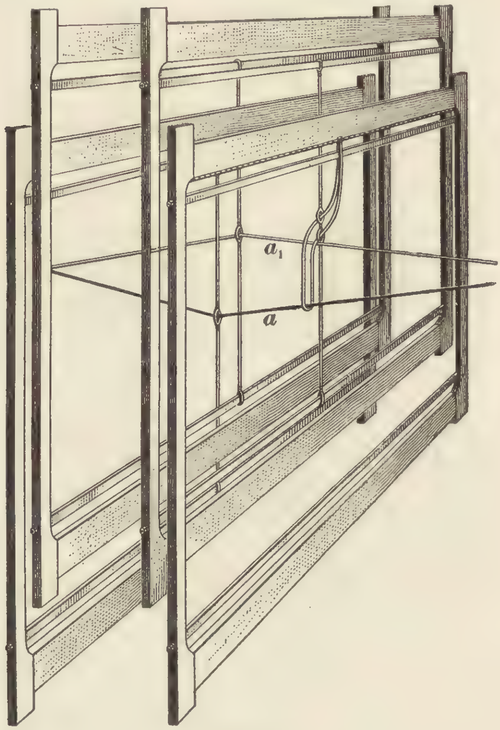


Fig. 17

doup slipping through the eyes of the standard heddle and allowing the back harness to retain the doup end *a* at the bottom of the shed as the standard harness is raised. The ground end a_1 is raised by lifting the ground harness, but in order that this may be done the standard harness must also be raised, allowing the ground end to rise between the doup and the standard heddle. The positions of the harnesses

and ends to form the shed for this pick are shown in Fig. 17. After the pick has been inserted, the harnesses are brought level at the bottom of the shed, as shown in Fig. 16.

On the next pick, the doup end *a* must be down on the opposite side of the ground end a_1. In order to accomplish this result, the doup and standard harnesses must remain

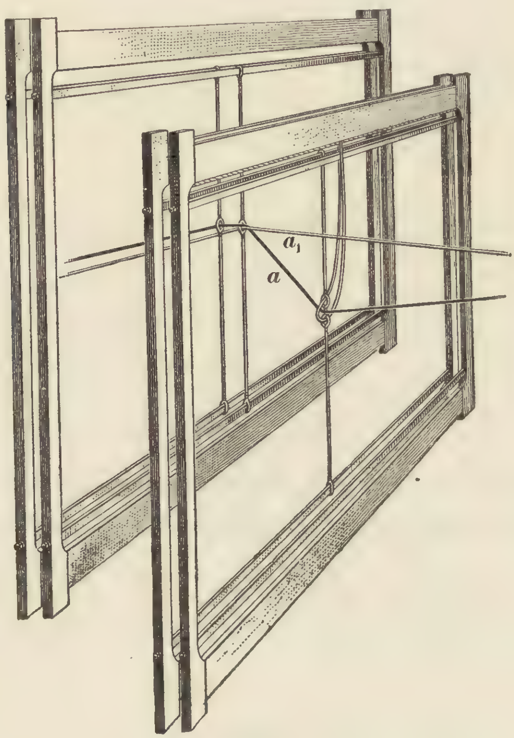


FIG. 18

down. Since on this pick the doup end *a* crosses the ground end a_1, which is raised by lifting the ground harness, the back harness must also be raised to avoid straining the doup end. As the crossing of the ends occurs on this pick, the doup end *a* must be eased by the operation of the slackener. Fig. 18 shows the position of the harnesses and ends on this pick. The leveling of the harnesses at the bottom of the

shed brings them into position for another repeat of the weave; the weave is completed by the 2 picks described.

20. The Weave.—Since the method of operating the doup and ground ends when using top doups differs from the method necessary when using bottom doups, the representation of the working of these ends, or the weave, will also differ. In the case of bottom doups, the representation of the weave, Fig. 12 (*c*), shows the doup end above every pick and crossing below the ground end between picks. With top doups the positions of the doup and ground ends are reversed, so that the representation of the weave must show the doup end below every pick and crossing above the ground end between picks. Fig. 19 illustrates the method of representing the gauze weave shown in Fig. 1 if it is woven with top doups. It must be remembered, however, that if Fig. 1 is considered as being

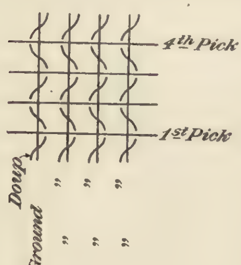


FIG. 19

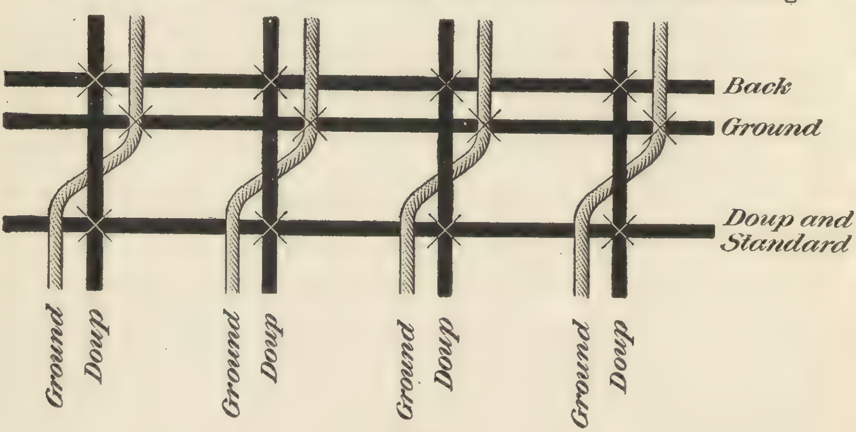


FIG. 20

woven with top doups the end a_1 represents the doup end, since when top doups are used the doup end is below every pick, and also that the end a is the ground end, which is raised over every pick.

21. The **harness draft** for top doups is made on the same principle as that explained for bottom doups and shown in Fig. 13. The only change that must be made is to indicate that in drawing in the ends the doup end must be crossed above the ground end. Fig. 20 is the harness draft for the 8 ends shown in Fig. 1 with the harnesses arranged for top doups, as in Fig. 16. The more simple harness draft made on the principle exemplified in Fig. 14 can easily be changed to apply to top doups by merely indicating on the draft that the doup end is crossed over the ground end when drawing in the warp instead of under it, as in the case of bottom doups.

22. The **chain draft** for top doups, giving the lifting of the harnesses on different picks, is made according to the method explained for bottom doups and shown in Fig. 15. When weaving with top doups, however, the doup end is below every pick that is inserted, whereas in the case of bottom doups its position is above every pick. It is therefore evident that in order to produce the same cloth with top doups as with bottom doups, the operation of the harnesses must be reversed. If on any pick the doup end is to remain down in its normal position, the doup and back harnesses are not lifted, but the standard and ground harnesses are. On the next pick, the doup end must be crossed over and depressed on the other side of the ground end, so that the doup and standard harnesses remain down and the ground and back harnesses are raised. As the crossing of the ends occurs on this pick, the slackener must be operated. After the insertion of this pick, the harnesses are returned to the bottom of the shed, ready for the next repeat of the weave. According to this method, Fig. 21 is the chain draft, which must be used in connection with the harness draft given in Fig. 20 in order to produce the fabric shown in Fig. 1.

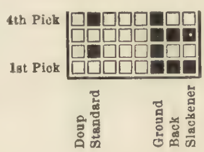


FIG. 21

23. There is only one noticeable advantage that top doups have over bottom doups in weaving plain gauze; that

is, that they are more easily repaired or replaced. As top doups are attached to the upper part of the doup harness, they are easily accessible for repairs or replacement; but in order to put in new bottom doups it is necessary for the weaver to reach down through the warp ends to attach the loops to the bottom part of the doup harness.

For reasons that will be given later, bottom doups are in more common use in weaving leno fabrics, so that all references in this Section, unless otherwise stated, should be understood to apply to them.

PLAIN GAUZE ON OPEN-SHED LOOMS

ADDITIONAL MECHANISMS REQUIRED

24. The description given so far refers to the weaving of plain gauze on a single-lift, or close-shed, dobby, in which all the warp ends are level at the bottom of the shed after the insertion of each pick. An understanding of the explanations that have been given will show that in order to make the crossing of the ends required in weaving plain gauze, it is necessary to have the doup and the ground ends level between the insertions of successive picks. This point need not be considered when weaving gauze with a close-shed dobby, for on such a loom all the ends are lowered after each pick.

When gauze is to be woven on a double-lift, or open-shed, dobby, this point is important, as it necessitates the use of extra mechanisms to bring the doup and ground ends level after the insertion of each pick. On such a loom, an end in the top shed is never lowered until it is required in the bottom shed on the next pick, and an end in the bottom shed is never raised unless it is required in the top shed on the following pick. As the standard and back harnesses are alternately raised and lowered on successive picks, their operation presents no difficulty with this type of loom. Since, however, the doup end is raised and the ground end depressed on every pick, additional mechanisms are applied to an open-shed dobby to raise the ground harness and lower

the doup harness to the center of the shed and return them to their original positions between the insertions of successive picks of filling, so that the ground and doup ends may meet and cross each other and then return to the bottom and top sheds, respectively. Two devices are used to enable the crossing of the doup and ground ends to take place; namely, the *jumper*, to operate the ground harness, and the *yoke*, to operate the doup harness.

25. The Jumper.—The most practical movement of the harnesses is to move each harness one-half of the full throw, so that the doup and ground ends are leveled at the center of the shed, as previously described. The **jumper** is designed to raise the ground end to the center of the shed and lower it again to its position in the bottom shed between successive picks.

Fig. 22 shows this mechanism. To the dobby rocker-arm e is attached an arm e_1 connected by a rod e_2 to a togglejoint e_3 that is hinged at e_4. This joint is connected at one end to the dobby frame at f and at the other end to an arm g attached to the shaft g_1, to which a segment h is set-screwed. Fastened to the top of the segment is a strap h_1 connected by a wire h_2 to a loop h_3 through which the dobby lever j passes. This loop must be at least equal in length to the distance that the lever will travel in lifting the harness half the distance of the shed, so as to allow h_3 to move as desired in weaving without interfering with the lever j, which, when plain gauze is being woven, is stationary. This arrangement of the dobby lever and the loop h_3 allows the lever to raise the ground harness, to which h_3 is connected in the ordinary way, to the top shed, as is often required when weaving fancy gauze, or leno, patterns, in the manner to be described later.

The dobby operates in such a way that the top and bottom arms of the rocker e move alternately outwards and inwards on successive picks. This motion is such that e_2 has a vertical movement, being raised on one pick and lowered on the next pick. Fig. 22 shows the position of the dobby

when the shed is formed and the rod e_2 is in its lowest position. As the rocker moves so as to form the next shed, the rod e_2 rises until it occupies, at the central point of its rise, the position shown in dotted lines. This movement has forced the togglejoint e_3 and the arm g into the positions shown by dotted lines. Since g and h are both fastened to g_1, the segment h has been moved to the right, thus lifting

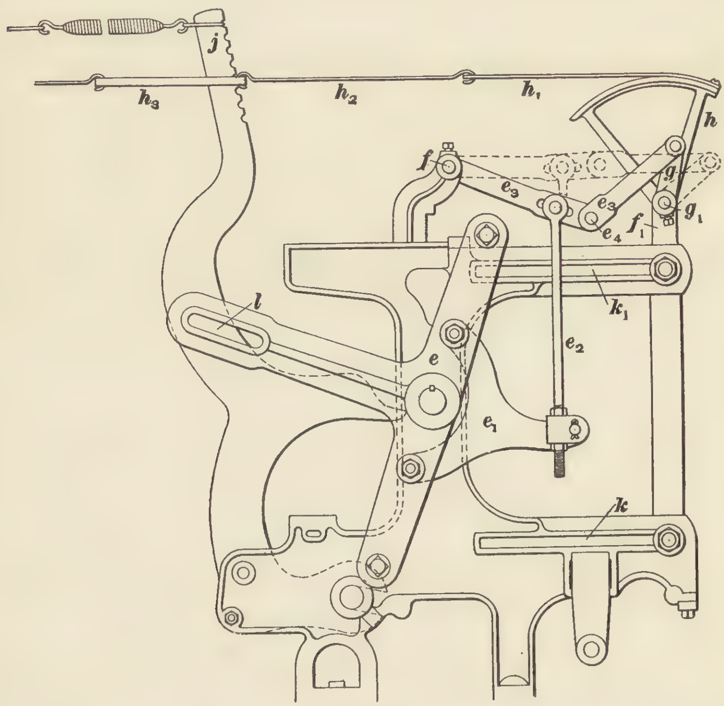


FIG. 22

the ground harness half the height of the shed. As the rod e_2 continues to rise, it will push the togglejoint e_3 still higher, but after it has passed its central position, it will draw the arm g to the left, causing the segment to move in the same direction, so that when the rod e_2 has reached the limit of its upward throw, the segment has reached its former position and lowered the ground harness to the bottom shed.

During the movement of the dobby, a new shed has been formed for the next pick, so that it will be evident that the desired result—that of raising the ground harness to the center of the shed and lowering it again—has been accomplished in the same time that it takes for a harness to change from one shed to the other. From this description it is evident that on the next pick the movement of the segment and, consequently, of the ground harness will be the same as that already described, although in this case the rod e_2 will move downwards. The jumper thus gives automatically all the movement required by the ground harness, bringing it from the bottom shed to the center and lowering it again between successive picks. Sometimes a spring, as shown in Fig. 22, is attached at one end to the dobby lever j and to the upper part of the frame of the loom at the other end, by means of a cord or strap. This keeps the dobby lever in place when the jumper is in operation.

26. The Yoke.—In weaving plain gauze on an open-shed loom, the doup end must also receive a movement equal to half the height of the shed, being lowered from the top shed to the center, to meet and cross the ground end, and then raised again between the insertions of successive picks. The device by which this movement is accomplished

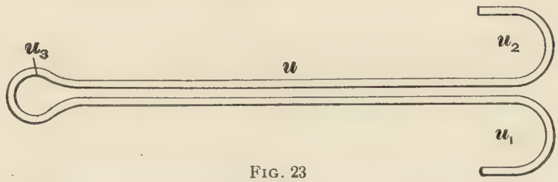


Fig. 23

is called the **yoke** and is shown in Fig. 23. The regular harness straps are attached to the doup, or first, harness, but these, instead of being fastened to the harness lever, are attached to the loop u_3 of the yoke. The hook u_1 is held in one of the notches of the first harness lever by the springs attached to the bottom of the harness. The standard harness is attached to the second lever of the dobby in the ordinary manner.

27. In weaving gauze, the doup harness is raised without the standard on the first pick, and the doup and standard harnesses are both lifted on the second pick. The first lever is operated in the ordinary manner, and in rising it carries with it the hook u_1, thus raising the doup harness.

On the second pick, on which the doup and the standard harnesses are raised, the second lever must be raised, thus raising the standard harness in the ordinary way; on this pick the first lever is lowered. As the lever moves down, it allows the yoke to move and lower the doup harness. When, however, the lever has reached the center of its throw, the second lever, which is rising, catches in the hook u_2 and, by carrying back the yoke, raises the doup harness to its former position in the top shed.

On the next pick, the harnesses must be brought to the position described for the first pick; this is accomplished by raising the first lever and lowering the second lever. When the yoke has lowered the doup harness to the center of the shed, by the lowering of the second lever, it is caught by the first lever as it is rising and raises the doup harness to its position in the top shed. From this description of the action of the yoke it will be evident that the doup harness will be up on every pick, but between successive picks will drop to the center of the shed and rise to the top shed again.

Thus the jumper and yoke give to the ground and doup harnesses the peculiar motions that are necessary if plain gauze is to be woven on an open-shed dobby. These movements of the harnesses, by raising the ground end and lowering the doup end, bring the ends level at the center of the shed, allowing the crossing to take place, and then carry the ends back to their original positions in time for the insertion of the next pick. This whole operation is accomplished in the same time that would be required for a harness operating in the ordinary way to move from the top to the bottom shed, or vice versa.

28. Harness and Chain Drafts.—When plain gauze is woven on an open-shed dobby with the jumper and yoke

attachments, the warp is drawn through the harnesses exactly the same as though a close-shed dobby were used; that is, the harness draft is the same in both cases.

The chain draft, however, is different from that used on a close-shed dobby. The jumper gives automatically the necessary movement to the ground harness, so that in making the chain draft for weaving plain gauze on an open-shed dobby, the squares that correspond to the ground harness require no marks. In making a gauze fabric on the machine under consideration, the ground harness need not be connected to any harness lever. It is usually so connected, however, when weaving fancy gauze, or leno, in the manner to be described later, in order to allow the ground end to be raised above the pick, as required, independently of the action of the jumper. The harness to which the jumper is connected is sometimes indicated on the chain draft, often by the letter *J* above the row of squares devoted to that harness.

With an open-shed dobby the working of the doup harness must be indicated in a different manner from that used for a close-shed dobby. If the doup harness were marked as in the latter case, it would remain in the top shed and the ends could not cross. If, however, the lever operating the doup harness is raised only on alternate picks, and the lever operating the standard harness is raised on the other picks, the doup end will be lowered between picks, so as to allow the crossing to take place, and will be raised on every pick by the yoke, which is alternately raised by the doup and the standard levers. The doup harness, therefore, on an open-shed dobby should be marked to rise only on alternate picks, since the standard lever, by means of the yoke, will raise it on the other picks.

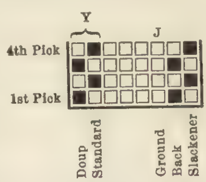


Fig. 24

The chain draft required for weaving the gauze shown in Fig. 1 on an open-shed dobby is given in Fig. 24, in which one method of indicating the harnesses connected by the yoke is shown; that is, by the letter *Y*.

GENERAL CONSIDERATIONS

29. In considering the weaving of plain gauze with top doups, the statement was made that so far as the weave or appearance of the cloth is concerned, it is impossible to distinguish the face from the back of the fabric. Theoretically, however, the side of the fabric that shows the doup end above the ground end between picks is the face. This, of course, is the side of the cloth that is undermost in the loom when the cloth is woven with bottom doups and uppermost when top doups are used. The reason for this designation is that the doup end by being often drawn considerably out of a straight line in fancy gauze weaves, because of its crossings, forms a distinct pattern on one side of the cloth, which is not produced on the other side, this side being therefore called the face, although in the case of bottom doups it is the side that is undermost in the loom. This difference between the two sides of the fabric will readily be discerned when fancy gauze, or leno, weaves are considered.

From this designation it will be evident that if the gauze shown in Fig. 1 was woven with bottom doups, a is the doup end and the cloth is woven face down; if it was woven with top doups, a_1 is the doup end and the cloth is woven face up. In weaving fancy gauze it is an advantage to weave the cloth face side up, since in this way it can readily be seen if the pattern is not weaving properly; but as top doups cannot be used for weaving all fancy gauze, or leno, fabrics, bottom doups are more commonly employed and the cloth, therefore, woven face down in the loom. In weaving plain gauze, however, there is no advantage in top doups in this connection, since both sides appear alike and broken ends are readily detected. Therefore, the only important advantage of top doups in weaving plain gauze is the ease with which they can be replaced when broken; and both top and bottom doups may consequently be used with little discrimination in such weaving on a close-shed loom.

In weaving plain gauze on an open-shed dobby, the only advantage of top doups would still be their easy replacement.

As this advantage is so slight and their use on an open-shed loom would necessitate the use of mechanisms different from the yoke and jumper used with bottom doups, in order to allow the doup and ground ends to cross between successive picks, top doups are seldom, if ever, used in weaving plain gauze. These remarks concerning the use and limitations of top doups in weaving plain gauze apply equally well to plain gauze when combined with other weaves, as described later in the consideration of fancy gauze.

Since there are no mechanisms in general use by means of which plain gauze may be woven with top doups on an open-shed loom, the use of these doups on such a loom is practically limited to those varieties of fancy gauze that can be woven on the same loom by bottom doups without the aid of the yoke and jumper; that is, those weaves in which there is at least 1 pick inserted between the picks on which the doup end appears on opposite sides of the ground end.

30. A careful consideration of top and bottom doups will make it evident that any gauze, or leno, weave that can be woven with top doups on either a close- or an open-shed loom can be woven with bottom doups, but that the use of top doups is limited to weaves produced on a close-shed loom or to those woven on an open-shed loom in which the doup and ground ends are not required to cross between successive picks. Because of their greater possibilities in leno weaving, bottom doups are in more general use than top doups.

Although the references made in the following treatment of fancy gauze will be understood to be to bottom doups unless otherwise specified, a knowledge of the facts just presented should enable the possibilities of reproducing the weaves shown with top doups to be determined.

FANCY GAUZE, OR LENO

METHODS OF PRODUCING FANCY GAUZE EFFECTS

31. In weaving plain gauze, the main object attained is the production of a fabric characterized by its open, or lace-like, appearance and by its great strength in proportion to its weight. In such a cloth the twisting of the ends does not produce a pattern, or a figured appearance. Fancy gauze, however, while it retains these features in a lesser degree, is characterized chiefly by its pattern, or figured appearance, produced by enlargements or variations of the plain gauze weave combined with each other or with weaves produced by the ordinary method of weaving. A sufficient number and variety of fancy gauze weaves will be here illustrated and explained to give an understanding of the methods employed in producing the almost unlimited number of different fancy gauze, or leno, patterns that are met with.

COMBINATION OF RIGHT-HAND AND LEFT-HAND DOUPS

32. One of the most effective as well as one of the simplest methods of producing fancy gauze, or leno, designs consists of varying the manner of drawing in the doup ends; that is, drawing a part of the ends through right-hand doups and others through left-hand doups. For illustration, suppose that the entire warp is composed of doup and ground ends, the doup ends being drawn through right-hand and left-hand doups alternately; then the drawing-in draft will be similar to that shown in Fig. 25, in which 4 ends constitute one repeat of the draft. Considering the ends in the order in which they are drawn through the back and ground harnesses, the first end at the left is a doup end, which is drawn through the back harness, then crosses under the

ground end, and is drawn through a left-hand doup. The second and third ends are ground ends, but the fourth end, which is the second doup end, is drawn through the back harness, crosses under the ground end, and is then drawn through a right-hand doup. Thus, while the first doup end is drawn through a left-hand doup, the second doup end is drawn through a right-hand doup. If, when weaving the cloth with the ends drawn in after the manner shown in Fig. 25, the ends doup on every other pick, as in pure gauze, the effect produced in the cloth will be similar to that shown

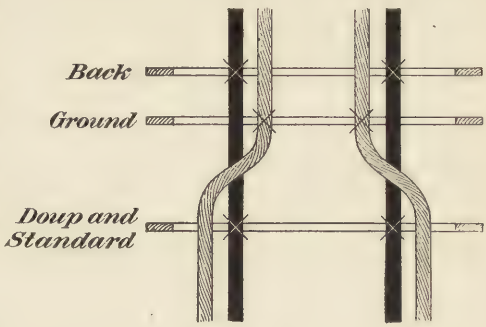


FIG. 25

in Fig. 26, where it will be seen that when one doup end is brought up on the right of its ground end, the other is brought up on the left of its ground end. When it is stated, as in the above case, that the ends doup on a certain pick, it is meant that on this pick the doup and standard harnesses are raised together so that the doup end crosses the ground end and is raised on the opposite side from that on which it would be raised normally by the back harness.

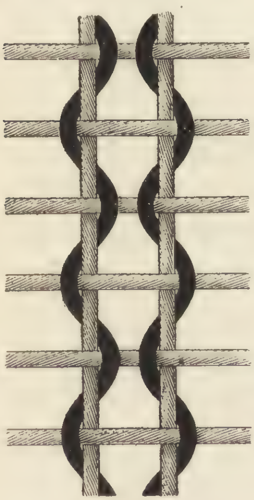


FIG. 26

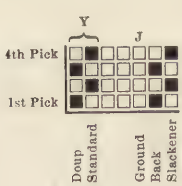


FIG. 27

The chain draft that would be used in producing the weave shown in Fig. 26, considering that the cloth is woven on an open-shed dobby, is shown in Fig. 27. On the first pick, the doup and back

harnesses are raised, which will have the effect of raising all the doup ends. As shown in the drawing-in draft, Fig. 25, the first doup end is drawn through a left-hand doup; therefore, when the doup and back harnesses are raised, this end will be brought up on the left of its ground end; this is the effect shown in Fig. 26. The second doup end is drawn through a right-hand doup; therefore, when the doup and back harnesses are raised together, this end will be brought up on the right of its ground end, as shown on the first pick in Fig. 26. On the second pick, as shown in Fig. 27, the back harness remains down, while the doup and standard are raised, the doup being raised by the yoke as the standard goes up. In this case the doup end drawn through the left-hand doup will be brought up on the right of its ground end, while the doup end drawn through the right-hand doup will be brought up on the left of its doup end; this is the effect produced on the second pick, as shown in Fig. 26.

All figures used to illustrate the effect of a leno draft in the cloth can give merely an idea of the manner in which the ends will interlace with the filling, since in almost every case where a fancy leno effect is produced, the picks as well as the ends are so pulled out of a straight line that it is rather difficult to represent them by the ordinary methods.

EFFECTS FORMED BY INSERTING TWO OR MORE PICKS BEFORE DOUPING

33. Fig. 28 shows another method of forming fancy leno effects, in which the doup end is made to cross several picks before the douping takes place. Thus, considering the bottom pick of Fig. 28 as the first pick of the weave, it will be seen that on the first 4 picks the doup end is brought up on the left of the ground end; on the next 4 picks it is up on the right of the ground end; while on the last 4 picks it is up on the left of the ground end. It is not necessary, of course, to have exactly this order of interlacing these 2 ends, since the doup end may be made to cross as many picks before douping as may be desired, it simply being necessary to build

the chain draft to give the desired weave. For the purpose of illustration it will be assumed that the doup end shown in this figure is drawn through a left-hand doup; consequently, it is brought up on the right of the ground end when douping; that is, on the fifth, sixth, seventh, and eighth picks.

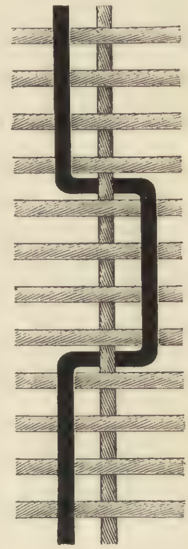


Fig. 28

The chain draft for Fig. 28 is shown in Fig. 29. On the first 4 picks the doup and back harnesses are raised, thus causing the doup end to be raised at the left of the ground end on these 4 picks, as shown in Fig. 28. On the next 4 picks the lever that actuates the standard harness is raised, thus lifting the standard, and also the yoke and doup harness, and bringing the doup end up on the right of the ground end. On these 4 picks the slackener is also operated in order to ease the yarn. On the last 4 picks the same harnesses are operated as on the first 4 picks, thus producing the same effect.

In this design a number of picks intervene between the crossing of the 2 ends; thus, on the first 4 picks the harnesses could remain in the same position, since each pick of filling is placed in the same shed. On each pick, however, the jumper raises the ground harness from the bottom to the center of the shed and then lowers it again to the bottom. This action, of course, places the warp yarn drawn through this harness in the proper position to have the filling inserted, but produces an unnecessary movement of the harness and consequently an unnecessary strain on the yarn. This positive action of the jumper is a disadvantage when producing an interlacing similar to that shown in Fig. 28.

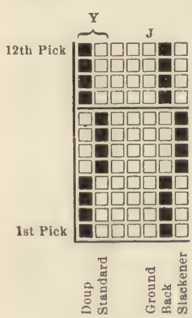


Fig. 29

34. Not only are these two methods of producing fancy leno effects frequently adopted separately, but they are also

often combined in the same cloth to produce another effect. This will be found to be true with all the weaves that will be explained, and although examples of every case may not be given, it should be understood that their combination is nevertheless possible.

WEAVES IN WHICH THE DOUP AND GROUND ENDS WORK PLAIN

35. Fig. 30 shows a weave in which the ground and doup ends are made to work plain for a certain number of picks and then caused to doup. Fig. 31 shows the chain draft for this weave. On the first pick, as shown in the chain draft, the ground harness is lowered, while the doup and back harnesses are raised, thus causing the doup end to be over, and the ground end to be under, the pick of filling. On the second pick the doup, standard, and back harnesses are lowered, while the ground harness is raised by lifting the dobby lever to which it is attached by the lever extending through the long loop that is a part of the connection between the ground harness and the segment of the jumper arrangement. Thus, on this pick the ground end will be over, and the doup end under, the pick of filling, producing a plain weave. The third pick is like the first, but on the fourth pick the doup and standard are raised, the ground and back harnesses are lowered, and the slackener is operated, thus producing a crossing of the ends. The next 2 picks are simply a repetition of the first 2 picks.

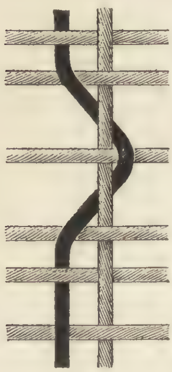


Fig. 30

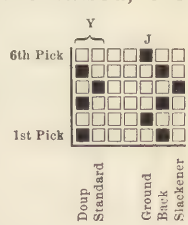


Fig. 31

Left-hand doups are used in this case, since the doup end is brought up on the right of the ground end when the douping takes place. Right-hand doups, however, could be used just as readily, and this will be found to be true of any illustration shown; that is, the crossing may be made either from right to left or from left to right, provided that the ends are

drawn in such a manner as to meet the desired requirements. With weaves similar to that shown in Fig. 30, the doup end should always be over the filling on the pick immediately preceding and following the pick on which the crossing takes place. Thus, in Fig. 30, on the fourth pick the douping takes place; consequently, on the pick immediately preceding this pick, or the third, the doup end is over the pick of filling. The same is true with regard to the fifth pick, which is the pick following the one on which the douping takes place. This point must always be considered when making a leno weave in which the doup and ground ends work plain throughout a part of the pattern.

36. Harness Draft.—When it is desired in a combination of several ground ends with 1 doup end to have the ground ends work plain during a part of the weave, it is necessary to draw each end that works differently through a separate ground harness. If, however, it is desired to use these ground ends simply for the purpose of letting them all make a turn with the doup end at the same time, they may be drawn through the same harness, since they may be operated as a single end.

WEAVES PRODUCED BY TWO OR MORE DOUP ENDS OR TWO OR MORE GROUND ENDS

37. Fig. 32 illustrates the manner in which the doup end may be made to cross more than 1 ground end and yet have all the ends in the weave work plain in those parts of the fabric where it is desired to produce plain cloth. On the pick on which the douping takes place the doup end crosses 3 ground ends; therefore, in the drawing-in draft the doup end must be drawn in such a manner that it will pass under 3 ground ends between the back harness and the doup and standard harnesses. Again, since there are 3 ground ends crossed by the doup end, these 4 ends must be drawn together in the same dent, in order to produce a crossing in front of the reed.

Noticing next the ground ends, without reference to the doup end, it will be seen that in that part of the weave that works plain, the first ground end, or the second end in the

illustration, works differently than the second ground end, while the last end works the same as the first ground end; consequently, while the first and third ground ends can be drawn through the same harness, the second ground end will have to occupy a separate harness, thus necessitating the employment of 2 ground harnesses. From this it will be seen that if the 4 ends shown in Fig. 32 constitute one repeat of the weave, the necessary harnesses to produce this weave given in the order in which they come in the loom will be as follows: Doup and standard harnesses, first ground harness, second ground harness, back harness.

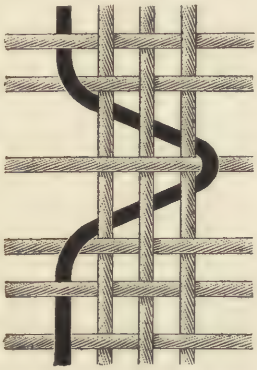


FIG. 32

38. Considering the manner of drawing in the different ends, the doup end is drawn through a left-hand doup; in drawing in this end, it will first be drawn through the back harness and then through the doup harness. The first ground end will be drawn through the first ground harness, crossed to the left over the doup end, and drawn through the same dent as the doup end. Since the second ground end works differently from the first, it will be drawn through the second ground harness, crossed over the doup end, and passed through the same dent. As the third ground end works the same as the first, it will be drawn in similarly to that end. This completes one repeat of the drawing-in draft, which is shown in Fig. 33.

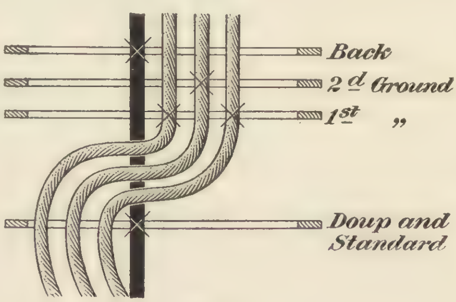


FIG. 33

39. Chain Draft.—In weaves similar to that shown in Fig. 32, it is customary to work both ground harnesses with

the same jumper attachment, but at the same time to have each harness connected to its individual lever, in order that each may be lifted in plain order when desired. The following is as simple a rule as any to follow when making a chain draft for these weaves. On the picks that are to work plain have the levers that work the ground harnesses lifted and lowered as they would be when producing a plain weave; on those picks on which the douping takes place have all the levers that work the ground harnesses lowered, since on these picks the jumper will perform all the necessary work. Fig. 34 shows the necessary chain draft for this weave. On the first pick the doup and back harnesses are raised, thus bringing the doup end over the pick of filling. On this pick, also, the first ground harness is lowered, while the second ground harness is raised. Since the first and third ground ends are drawn through the first ground harness, and this harness is lowered on this pick, these ends will be under the pick of filling. Since the second ground end is drawn through the second ground harness, which is raised on this pick, the second ground end will be over the pick of filling, as shown in Fig. 32.

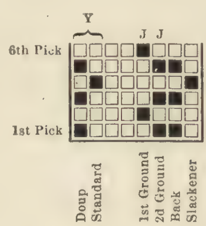


FIG. 34

On the second pick, as shown in the chain draft, the only harness that is raised is the first ground harness, and since the first and third ground ends are drawn through this harness, these ends will be over the pick of filling, while the other ends will be under the pick of filling. The third pick is the same as the first.

On the next pick, however, the standard and doup harnesses are raised—the latter by the yoke—and the slackener is operated, thus bringing the doup end up on the right of the 3 ground ends and causing a turning of the ends. When causing a turn in the ends on an open-shed dobby, it is necessary to bring all the ends level at about the center of the shed. With the weave being illustrated, this is accomplished as follows: On the third pick the doup end is over the pick of filling, which is in accordance with the instructions

previously given that the doup end should be over the filling on the picks immediately preceding and following the pick on which the douping takes place. On the fourth pick the doup and back harnesses are lowered, which causes the doup end to drop, but the standard harness is raised. As the lever operating the standard harness rises, it will catch the hook attached to the doup harness when the doup end has dropped half the space of the shed, and thus this end will be brought from the top of the shed to the center and then back to the top again.

Considering next the first and third ground ends, which work alike and are therefore drawn through the same harness, it will be seen that on the third pick they are both down; consequently, on the fourth pick some means must be adopted to bring them to the center of the shed and then lower them again. According to the chain draft, on the fourth pick the lever operating the first ground harness through which these ends are drawn is not raised; but, since this harness is also attached to the jumper, it will be under the control of this mechanism when not lifted by its lever, and will therefore be brought to the center of the shed and then lowered to the bottom. On the third pick the second ground end is raised, while on the fourth pick it is lowered; consequently, in passing from the top of the shed to the bottom, it will necessarily meet the other ends at the center. It is in this manner that on the pick on which the douping takes place the doup end and the ground ends are brought level at the center of the shed, permitting the crossing of the ends. The fifth and sixth picks are similar to the first and second, respectively.

40. The weave shown in Fig. 32 is typical of a large variety of weaves in which 1 doup end crosses 2 or more ground ends. Though the variations in the interlacings of these ends are many, they present no difficulties to one who understands the method of reproducing the weave given in Fig. 32.

Weaves of this character might be made by having 2 or more doup ends drawn through separate back harnesses,

under 1 ground end, and through the same doup, but as this method is not as convenient as that just described, it is not used to any extent.

41. A common method of obtaining leno effects is by a combination of the two methods just mentioned; that is, by having 2 doup ends drawn through 2 back harnesses, under 2 ground ends, which are drawn in 2 harnesses, and then through 1 doup harness at the front. A leno pattern obtained in this way is shown in Fig. 35, the harness and chain drafts being given in Figs. 36 and 37. The pattern is complete on 8 picks, though in Fig. 35 the first pick is repeated, in order to show the complete working of the ends. In this system, it is evident that as the doup ends are both drawn through the same doup, which is raised by the standard harness when

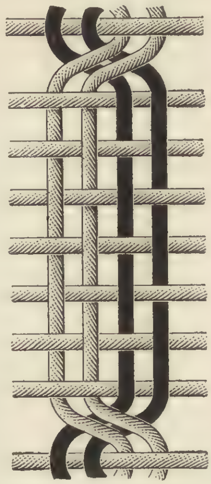


FIG. 35

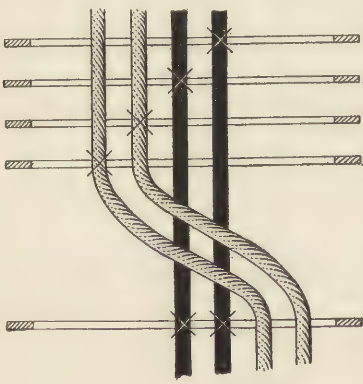


FIG. 36

the douping takes place, these ends must be raised together when this action occurs. Though the doup ends are thus limited when raised out of their normal position the ground

ends are not restricted and may be operated separately as desired on all douping picks; it is seldom, however, that the ground ends are worked separately on such picks, it being customary, in order to bring out the full effect of the crossing of the ends, to depress both ground ends on the pick, or picks, inserted when the doup ends are raised out of their normal position. When the doup harness is raised and the standard harness remains down, the doup ends can be raised independently of each other and of the ground ends, since they are raised in their normal position, and as the ground ends can also be operated independently, all 4 ends can be utilized to weave plain cloth as shown in Fig. 35, picks 3 to 7, inclusive.

This weave necessitates a different use of the yoke from that explained in connection with the weaving of gauze on an open-shed dobby, where the doup harness is readily operated so as to prevent any great amount of slack in the doup, which slackness would be liable to entangle and break the ends. If the 2 doup ends, which are drawn through the same doup, as shown in Fig. 36, worked alike throughout the weave, as they do on the first 2 picks of the weave shown in Fig. 35, the arrangement of the yoke connected with the doup and the standard harnesses would be the same as that used in weaving plain gauze on an open-shed loom with 1 doup end crossing 1 ground end. When, however, as in this case, the doup ends drawn through the same doup work differently, two levers are required to operate the doup harness, while the standard harness is operated by the third lever, to which it is attached in the ordinary manner. As has been stated, the first 2 picks present no difficulty, because the doup ends work alike, so that if the doup harness is worked correctly as for 1 doup end, the doup will remain practically taut throughout its movement. On the third pick, 1 doup end is depressed, but the other doup end is raised and retains the doup in position; consequently, no difficulty is

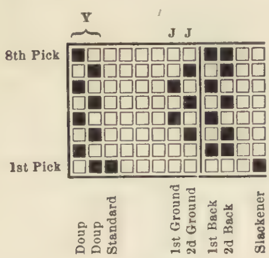


Fig. 37

experienced on this pick. On the fourth pick, however, the positions of the doup ends are reversed; as the end that was raised on the previous pick descends, it will allow the doup to become slack until it meets, at the center of the shed, the other doup end, which is rising, unless at the same time the doup harness is moved to the center of the shed and returned to the top shed. This movement is the same as that which would be given if the yoke were attached to the levers operating the doup and the standard harnesses; but as the lever operating the standard harness is not raised on the next pick, this arrangement cannot be used.

In order to give the required movement to the doup harness the yoke is connected to the first two levers of the dobby, but is entirely independent of the third lever that operates the standard harness. The yoke, to which the doup harness is connected, is attached to levers that operate in the same way as the doup and standard levers when connected by a yoke, as previously explained. As the doup harness is lowered by one of the levers to which the yoke is attached, the doup is lowered to the center of the shed at the same time that the end previously raised is descending; the doup harness is then raised by the other lever while the end previously depressed is rising; consequently, the doup is kept practically taut, and tangling and breaking of ends is avoided.

In weaves of this character the standard harness is operated as required, independently of the two levers connected by the yoke for the purpose of operating the doup harness. The first two levers are operated alternately on all picks where the doup ends work differently, in order to lower the doup harness to the center of the shed and return it to its position between successive picks. One of the yoke levers should, of course, always be raised whenever the standard is raised to enable the douping to take place.

EFFECTS REQUIRING MORE THAN ONE SET OF DOUP ENDS

42. In many leno weaves, the douping of one set of ends occurs on one pick while the douping of another set occurs on another pick. In such cases, it is necessary to employ as many sets of doup and standard harnesses as there are sets of doup ends. Two sets of doup and standard harnesses are the most common, although in some cases more are used. A good plan to follow when seeking to determine the number of ends that doup differently, is first to determine the doup ends in one repeat of the pattern of the weave, and next to follow the interlacings of the different picks and determine the number of sets of doup ends that doup on different picks. If one set of doup ends is found to doup on a different pick than the others, those ends require a separate doup, a separate standard, and a separate back harness; that is, there must be as many different sets of these harnesses as there are different sets of doup ends that work differently.

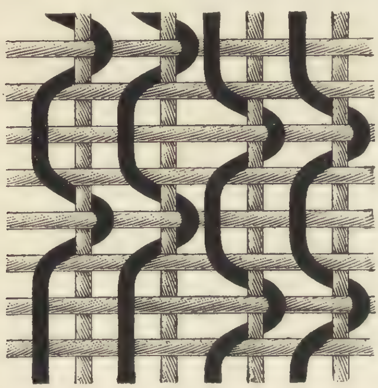


FIG. 38

Fig. 38 illustrates this point somewhat more clearly; on the second and sixth picks the third and fourth doup ends doup, while on the fourth and eighth picks the first and second doup ends doup. Consequently, in this weave there are two sets of doup ends, which are actuated by two sets of harnesses; that is, the first 2 doup ends are drawn through one set of harnesses and the last 2 doup ends through another set.

When more than one set of doups are used to weave a fabric, the order in which the harnesses are usually arranged is as follows: doup, standard, doup, standard, and so on, until the number of doups and standards that are required

are used; next follows the ground harness for the end that is crossed by the doup end drawn through the front doup, and next the back harness for that doup end; after this follow the ground and back harnesses for each set of doup and standard harnesses in regular order. This order, although not always adopted, is the general one and will be found to give the best satisfaction.

43. Considering the drawing-in draft for Fig. 38, the first 2 doup ends work alike and also the first 2 ground ends; therefore, one set of doup, standard, ground, and back harnesses will serve for these 4 ends, left-hand doups being used. The third and fourth doup ends, although they work

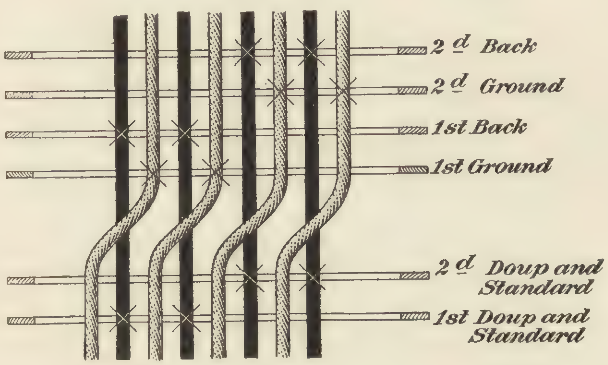


FIG. 39

alike, work in a manner entirely different from the first and second doup ends, and while they may be drawn in similarly to each other, they must occupy a separate set of harnesses from the first 2 doup ends. The same is true of the third and fourth ground ends when considered in relation to their respective doup ends and the first and second ground and doup ends.

The complete drawing-in draft for these ends is shown in Fig. 39; the first doup and standard harnesses, the first ground harness, and the first back harness are used for the first 4 ends of Fig. 38, while the remaining harnesses are used for the second 4 ends. Fig. 40 shows the chain draft that will give the effect shown in Fig. 38 with the ends drawn in

as shown in Fig. 39. Considering the first pick of Fig. 40, the first doup and first back harnesses are raised, which raises the first and second doup ends; the second doup and second back harnesses are also raised, which raises the third and fourth doup ends. As the other harnesses are not lifted on this pick, the remaining ends will be down. On the second pick, the second standard harness is raised, which by means of the yoke raises the second doup harness, causing the third and fourth doup ends to doup. The first doup and first back harnesses are also raised on this pick, which will cause the first and second doup ends drawn through these harnesses to be lifted. The third pick is the same as the first. On the fourth pick, the first standard, and consequently the first doup, harnesses are raised, causing the first and second doup ends to doup. As the second doup and second back harnesses are also raised, the third and fourth doup ends will be up on this pick. The last 4 picks are simply repetitions of the first 4 picks. Each set of doup and standard harnesses must have its own slackener; thus, Fig. 40 provides for two slackeners, one for the first set of doups and another for the second set. When the first and second doup threads are made to doup, as they are on the fourth and eighth picks, the first slackener is operated, while the second slackener is operated when the third and fourth doup ends are douped, as on the second and sixth picks. In every case where more than one set of doup ends is adopted there must be a slackener for each set and the doup ends drawn over their respective slackeners.

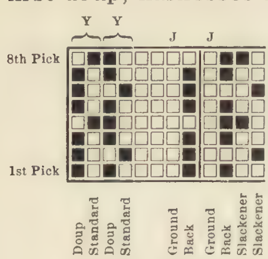


FIG. 40

44. It is possible to weave on a comparatively small number of harnesses a variety of leno effects somewhat elaborate in appearance that seem to require a large number of harnesses for their production. In such weaves separate back and ground harnesses are required for each pair of doup and ground ends that work differently from every other pair.

Only 1 doup and 1 standard harness is used, however, all the doup ends being drawn through doups on the one doup harness, as they all doup on the same picks. Such an arrangement is possible because on every alternate pick the doup and standard harnesses are both raised, while on the other picks the doup harness alone is raised. On the picks first mentioned, every doup end is raised out of its normal position by the lifting of the doup and standard harnesses. On the second pick and every alternate pick, there are two possible manipulations of the ends that work together, so that either the ground end or the doup end may be raised. In the first case the ground end is raised by lifting the ground harness, but as the back harness remains down the doup end is down and, consequently, the doup retains its position, although the doup harness is lifted. In the second case the doup end is raised by lifting the back harness, this being possible because, as already noted, the doup harness is raised on this pick.

If the pick on which the doup end is raised out of its normal position is alternated with the pick on which the ground end is raised, it will result in weaving plain cloth. If the pick first mentioned is alternated with the pick on which the doup end is raised in its normal position, the result will be plain gauze. Since each pair of doup and ground ends is drawn in on separate back and ground harnesses, it is evident that one pair of ends may weave plain cloth and another pair weave plain gauze throughout a repeat of the weave, or that any pair of ends working together may weave plain cloth for part of the weave and plain gauze for the remainder. The latter method is in general use for producing elaborate effects with a relatively small number of harnesses. In such weaves a groundwork of plain cloth is produced by raising the ground ends on those picks where there is a choice in the working of the ends, and the design is made by weaving plain gauze by raising the doup ends on the required number of these same picks.

Fig. 41 shows the weave of a leno design made on this principle, which will give a zigzag effect in the cloth, and

Figs. 42 and 43 show the requisite harness and chain drafts, the latter being for a close-shed loom. The weave is complete on 16 picks, though Fig. 41 gives the last pick of the previous repeat and the first pick of the following repeat of

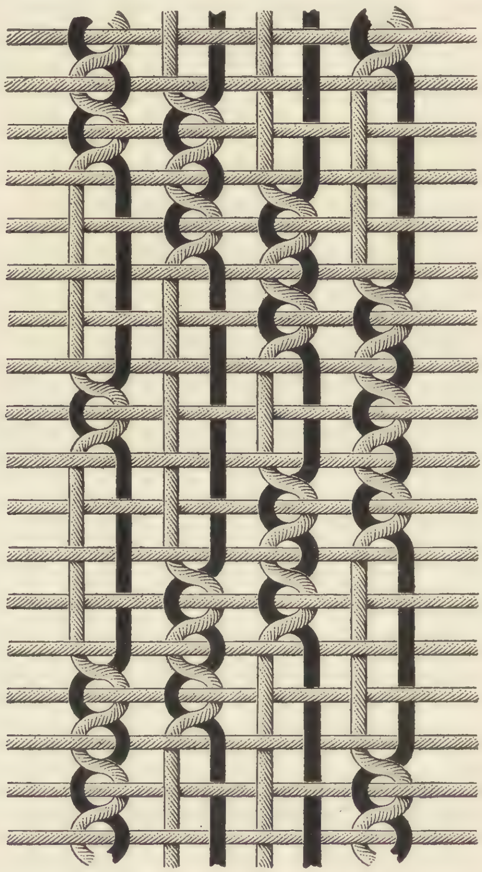


Fig. 41

the weave. This weave shows the features peculiar to leno fabrics woven on this principle with only one set of doup and standard harnesses. On the second and every even-numbered pick, every doup end is raised out of its normal position. On the first and every odd-numbered pick, certain doup ends are

raised in their normal positions, while certain others remain down and the ground ends that work with them are raised.

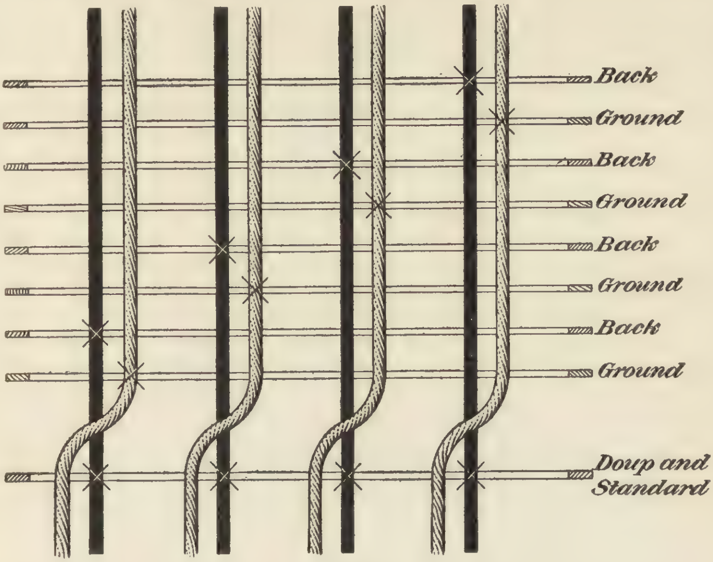


FIG. 42

In either case the ends are raised on the side opposite to that on which the doup ends were raised on the previous pick.

45. A simple and accurate method of making weaves of this character is as follows: Mark on design paper as a motive the effect that is desired. Then on the chain draft allow for 1 doup harness, 1 standard harness, 1 slackener, and twice as many harnesses for the doup and ground ends as there are ends in the motive that work differently; also allow for twice the number of picks required by the motive; the allowance for ends is made because each end of the motive represents 2 ends—a doup and a ground end working together—and the allowance

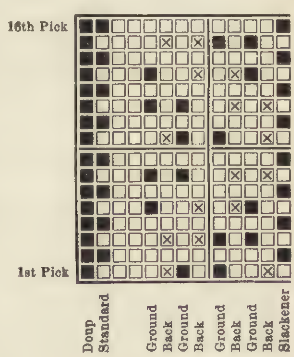


FIG. 43

for picks because in weaving the design all the pairs of ends must weave alike on half the picks. In making the chain draft, mark every alternate pick to raise the doup and the standard harnesses and operate the slackener. These picks will always be marked alike, irrespective of the design, and on these picks no marks are ever placed to operate any of the ground or back harnesses. Next mark the draft to raise the doup harness on all those picks that have not been marked. Since it is on these picks that the choice is given of raising either the ground or the doup ends, and the desired figure is produced by raising certain doup ends so as to weave plain gauze, the design should be marked on the back harnesses on these picks. As the last step, mark the chain draft on these same picks to raise the ground harness of every pair of ground and back harnesses, where the back harness has not been marked to raise the doup end drawn through it. The motive for the weave shown in Fig. 41 is given in Fig. 44, and is shown properly placed on the chain draft by the crosses in Fig. 43.

FIG. 44

The principles involved in producing leno effects by this method are fully explained with reference to the weave shown in Fig. 41, which is sufficiently large to give the desired effect on certain classes of goods. On many fabrics, however, it is necessary, in order to bring out the effect to the greatest advantage, to use all the available harnesses for the differently working pairs of ends, and to extend the number of picks proportionately.

COMBINATION LENO EFFECTS

46. Although the illustrations given deal only with doup and ground ends, leno effects are not made up entirely of these, since almost all leno patterns are made by combining a plain or fancy gauze weave with some other weave of ordinary structure, thus forming stripes, checks, and many other effects. With the designs so far given, it has been the object to explain the different leno weaves that are commonly used in combination with some other weave, and it

should be understood that it is possible to combine any of these weaves, or, in fact, several of them, with other weaves, such as plain or twill, and in this manner form numerous and varied effects.

47. When weaving a gauze, the back harness and the harness through which the ground ends are drawn should be placed as near the back of the loom as possible and operated by the back levers of the dobby, in order to give the doup ends room in which to cross the ground ends. In cases where a leno design is composed of some other weave in addition to the gauze, it is the custom to place the harnesses carrying the ends forming this weave between the standard and the ground harnesses and to have them operated by the center harness levers of the dobby. In all illustrations given of this class of weaves, this order of placing the harnesses will be observed.

48. Combinations of Plain and Gauze Weaves. Fig. 45 shows a leno design in which the first 24 ends work plain, producing a stripe of plain weave. The remaining ends produce a stripe of gauze, but while some of the ends are douping to the right, others are douping to the left, and as all these ends do not interlace with the filling in exactly the same order, widely varied effects are produced. The first point to determine when reproducing a leno fabric is the number of sets of doup harnesses necessary for the doup ends. When a doup end is found to doup on a pick on which the other doup ends do not, that end must have a separate doup and standard harness. On the first pick shown in Fig. 45, all the doup ends are operated in the same manner; consequently, as far as this pick is concerned, only one doup and standard harness are necessary. The same is true of the second and third picks. On the fourth pick, however, two methods are adopted, since while the first two and also the last two sets of crossing ends doup on this pick, the second two do not, but remain as they were on the third pick; consequently, thus far at least two sets of doup and standard harnesses are necessary. Comparing the interlacings of the

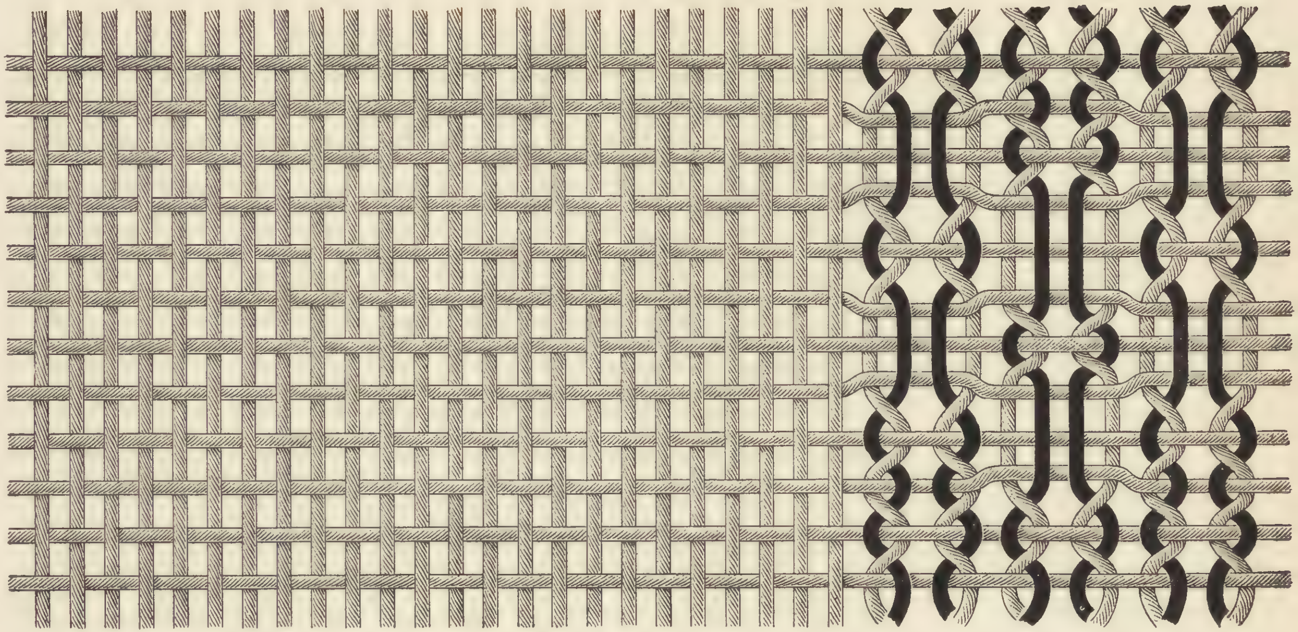


FIG. 45

doup ends on each pick of Fig. 45, it will be seen that two sets of doup harnesses will be sufficient to weave this design, since these are the only two sets of doup ends that work differently.

Having determined the number of doup and standard harnesses, next learn in the same manner the number of ground harnesses required. When each doup end crosses only 1 ground end, as is the case in this figure, there will be the same number of ground harnesses as there are doup harnesses. The number of back harnesses will, of course, be the same as the number of doup harnesses in every case, with the exception of weaves made on the principle of that shown in Fig. 41. The ends so far considered will require 2 doup, 2 standard, 2 back, and 2 ground harnesses, making eight levers of the dobby that will be required for this part of the weave.

The first 24 ends of Fig. 45 can be placed on 2 harnesses, since this is the plain weave. However, it would be better to draw them in on 4 harnesses, which method will be adopted. It also becomes necessary before making out the harness draft, to determine which ends are drawn through right-hand doups and which require left-hand doups. Referring to Fig. 45, the first, third, and fifth doup ends are drawn through right-hand doups, while the second, fourth, and sixth doup ends are drawn through left-hand doups. It is possible now to commence to make the harness draft, shown in Fig. 46, the ends and the harnesses, through which they are to be drawn, being as follows: The first and second harnesses are the first doup and the first standard harnesses, through which the first, second, fifth, and sixth doup ends are drawn; the third and fourth harnesses are the second doup and the second standard harnesses, through which the third and fourth doup ends are drawn; the fifth, sixth, seventh, and eighth harnesses have the ends working plain drawn through them; the ninth harness is a ground harness, through which the first, second, fifth, and sixth ground ends are drawn; the tenth harness is a back harness, through which the first, second, fifth, and sixth doup ends are drawn; the eleventh harness is

a ground harness, through which the third and fourth ground ends are drawn; the twelfth harness is a back harness, through which the third and fourth doup ends are drawn.

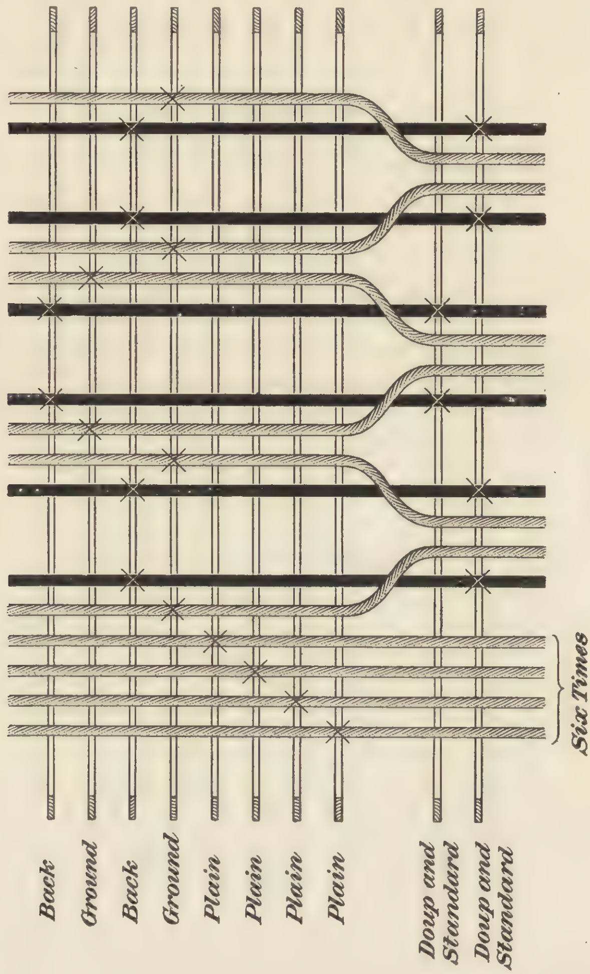


FIG. 46

49. As it is always necessary to have as many slackeners as there are sets of doup and standard harnesses, two slackeners will be required in this case, which will necessitate using two more levers of the dobby, making fourteen

altogether. When a gauze weave is combined with some other, such as plain, as in Fig. 45, it is customary to have at least a slight space between the front harnesses that carry the doup ends and the harnesses through which the ends forming the other weave are drawn. It will be assumed that with this weave two levers are omitted between those operating the two sets of doup and standard harnesses, and those operating the harnesses carrying the ends that work plain. The harnesses and dobby levers will therefore be connected in the following manner: First lever operates first doup harness; second lever operates first standard harness; third lever operates second doup harness; fourth lever operates second standard harness; fifth lever skip; sixth lever skip; seventh lever operates first plain harness; eighth lever operates second plain harness; ninth lever operates third plain harness; tenth lever operates fourth plain harness; eleventh lever, also jumper, operate first ground harness; twelfth lever operates first back harness; thirteenth lever, also jumper, operate second ground harness; fourteenth lever operates second back harness; fifteenth lever operates slackener for first set of doups; sixteenth lever operates slackener for second set of doups. The first and second and third and fourth levers are, of course, connected with yokes. Thus, with the harnesses arranged in this manner, a dobby with a capacity of at least sixteen levers will be required to weave the cloth, although, by not skipping any levers and by drawing the plain ends on 2 harnesses, it would be possible to reduce this number to twelve.

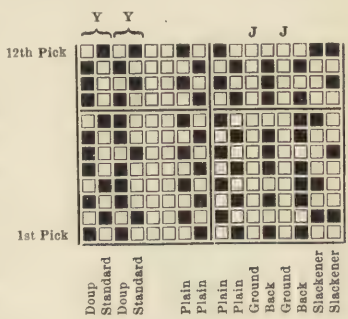


Fig. 47

50. Fig. 47 shows the chain draft for the weave Fig. 45 with the ends drawn in as shown in Fig. 46; by following each pick of Fig. 47 it should be readily seen how the effect

is obtained. On the first pick the following harnesses are raised: second plain harness, fourth plain harness, first doup, second doup, first back harness, second back harness. Consequently, all the doup ends are raised over the filling but do not doup; also, all the ends drawn through the second and fourth plain harnesses are raised over the filling. On the second pick the following harnesses are raised: first plain harness, third plain harness, first standard, second standard, both slackeners. This causes all the doup ends to cross, and brings up the ends drawn through the first and third plain harnesses. Following each pick through in this manner, it will be seen that in each case the effect shown in Fig. 45 will be obtained.

EFFECTS OBTAINED WITHOUT THE USE OF ADDITIONAL MECHANISMS

51. Many good leno effects are obtained on open-shed looms without the use of additional mechanisms for causing the doup and ground ends to meet in the center of the shed by having the doup end both over and under the picks, but never interlacing with successive picks on opposite sides of the ground end, or ends, with which it works; that is, at least 1 pick is inserted between the picks on which the doup end interlaces on opposite sides of its ground end, or ends. It is evident that such weaves can be woven with top doups; therefore, since top doups are more convenient, and as they weave the cloth face up in the loom, they are often employed in preference to bottom doups in producing the leno effects described. Fig. 48 shows a weave of this type, the doup end being under some of the picks and over the other picks. Suppose that top doups are used; then on the first 2 picks the doup end is

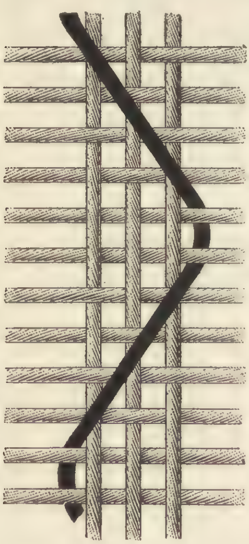


FIG. 48

carried down on the left of the ground ends; on the next 4 picks the doup end is up; but on the next 2 picks it is carried down on the right of the ground ends. If left-hand doups are used, the douping will take place on these 2 picks, but since the doup end has been up for the previous 4 picks, there is no necessity for any additional attachments to cause the doup and ground ends to meet in the center of the shed in order to produce the douping; that is, since the doup end is up on the previous pick, it is perfectly evident that the doup end is in such a position as to enable it to meet and cross the ground ends without any additional movement being imparted to it, whereas if it were down on the previous pick, it would have to be so

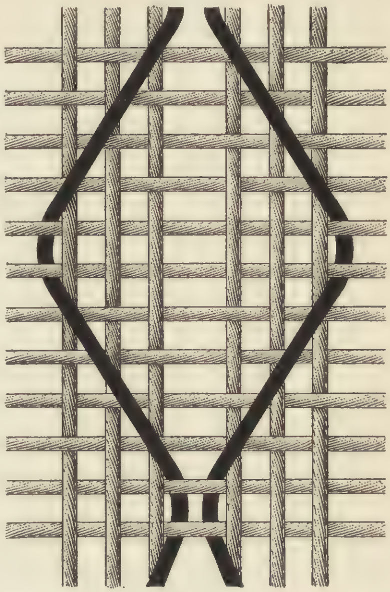


FIG. 49

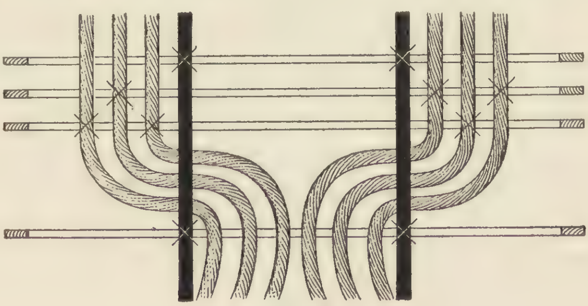


FIG. 50

operated as to meet and cross the ground ends before the insertion of this pick, which would necessitate the use of additional mechanisms. Weaves of this character are not

strictly leno weaves, but the effects produced are in many cases very similar to lenos.

The appearance of a cloth with a weave similar to that shown in Fig. 48 is greatly improved by using both right-hand and left-hand doups, which give a diamond effect, as shown in Fig. 49. The drawing-in draft for the weave shown in Fig. 49 when using top doups is shown in Fig. 50; Fig. 51 shows the chain draft.

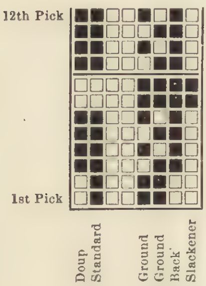


Fig. 51

Plain, twill, satin or other weaves may be introduced between the doup ends, as shown in Fig. 52. The drawing-in draft with top doups is shown in Fig. 53, and the chain draft in Fig. 54. In Fig. 53 it is indicated that the ground ends are to be drawn 2 ends per eye. This

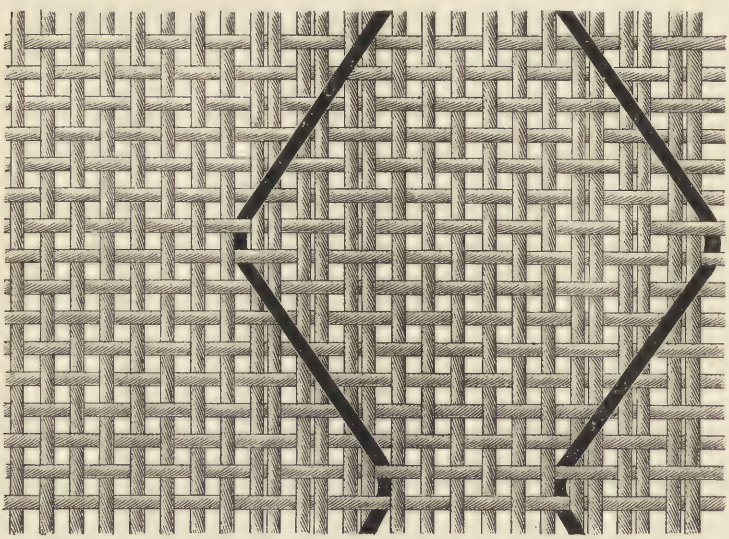


Fig. 52

means that each of the 3 ground ends, shown crossed by 1 doup end, represents 2 ends, which as shown in Fig. 52 work exactly alike. These 2 ends are drawn through the

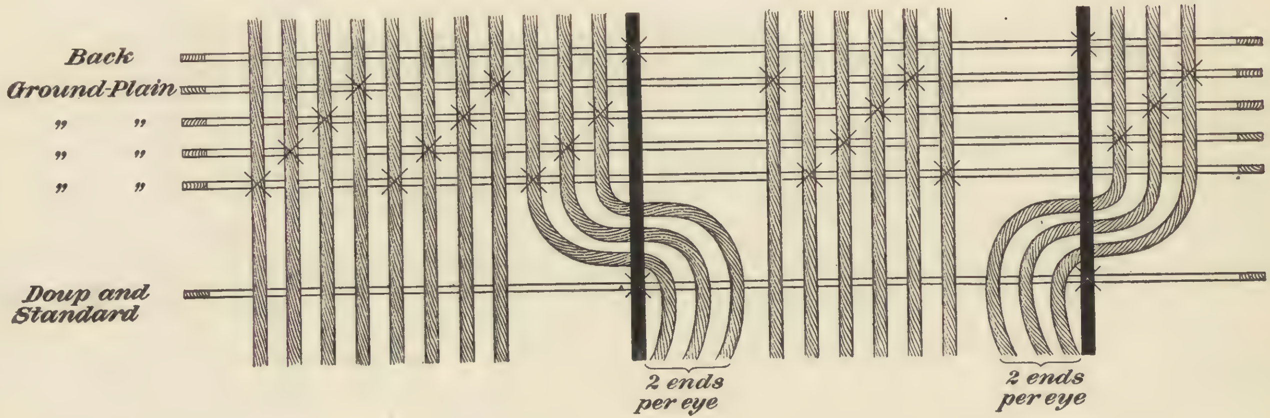

Back
Ground-Plain
" "
" "
" "
Doup and Standard
2 ends per eye
2 ends per eye

Fig. 53

harnesses as one end, and therefore, although in Fig. 53 only 3 ground ends are shown, each doup end virtually crosses 6 ground ends.

EFFECTS PRODUCED INDEPENDENTLY OF THE WEAVE

52. There are several ways in which the peculiar effects of leno weaving may be emphasized so that the design produced by any leno weave may be made more prominent without changing the weave itself. One of these methods is to use colored yarns for some of the ends, which may be either the doup or the ground ends. When this method is adopted, the best effect is usually obtained by making the doup ends the colored ends.

Different-sized yarns are also used to heighten the leno effects, in which case they may be either ground or doup ends. If the ground ends are heavier than the doup ends with which they work they will force the doup ends farther from a straight line, thus increasing the zigzag effect. If the doup ends are heavier than their respective ground ends, they will show more prominently as ends, but they will not show as much deviation from the other warp threads. The heavy ends may be either single yarn of coarse counts or ply yarn composed of two or more strands of single yarn twisted together. An effect similar to that obtained by using heavy ends is produced by drawing 2 ends as one for either doup or ground ends.

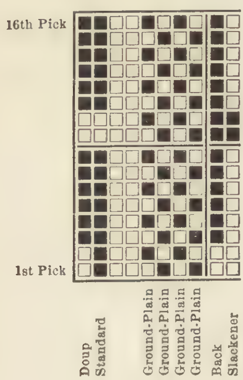


FIG. 54

53. Another important matter affecting the prominence of the leno effects is the regulation of the tension of the beams. In leno weaving the same precaution must be taken as in ordinary fancy weaving; namely, ends that vary considerably from other ends in take-up must be placed on separate beams. It will usually be found that only one beam is required when weaving plain gauze, though two

beams are sometimes used so that the tension of the doup ends may be regulated as desired in weaving fancy gauze; however, several beams are usually required.

In a fancy-gauze fabric the take-up of the ends that weave in the ordinary way is determined by their interlacings. The take-up of the doup ends, however, is dependent not only on their interlacings, or the number of times they cross their respective ground ends, but also on the number of ground ends crossed; the greater the number of ends crossed, the greater will be the take-up of the doup ends. When more than one beam is used, it is customary to place the largest beam in the usual position in stands on the frame of the loom. The other beams are placed in a vertical row above this beam with the smallest beam at the top, the ends resting in adjustable stands placed on rods attached to the back part of the loom. This arrangement of the beams according to their size is adopted because a heavy beam, if placed above the loom, is liable to break some part of its comparatively weak supports, and in falling to break the loom or injure any one who is near it.

When doup ends are placed on a beam that occupies a position in the loom above the slackener rod, they are drawn and operated as already described, except that they are passed under the slackener rod. This general method is varied to a considerable extent in adapting it to peculiar conditions under which leno fabrics are often woven.

The result generally sought in leno weaves is the largest possible deviation of the doup ends from the straight line taken by the other ends, and this is accomplished by putting considerable tension on the beam carrying the ground ends and by placing little tension on the beam containing the doup ends, so that the ground ends tend to retain their position and force the doup ends to make a sharp angle with the other ends. The proper regulation of the proportionate tension of the different beams, though apparently a simple matter, contributes very largely to the effectiveness of any leno weave.

DISSECTING LENO WEAVES

54. When seeking to pick out a leno weave and to find all the particulars necessary for reproducing a cloth of this character, it should be understood that it is not possible to ascertain the weave, at least the gauze part of it, by picking out each pick separately and marking its interlacings on the design paper. The best plan to follow is to study the weave carefully with the aid of the pick glass, endeavoring to understand the method of interlacing that is employed, and after this has been learned, to mark out the chain draft on the design paper.

55. In a great many leno fabrics open spaces occur between the different sets of doup ends. This is caused by leaving a number of dents in the reed empty and having several ends drawn through other dents. The crossing of the ends that takes place in gauze weaving retains the ends in their proper positions when in the cloth, which would not be the case if any dents were left empty when weaving an ordinary fabric.

In cases where a doup end crosses several ground ends that work plain part of the time, as in the weave shown in Fig. 32, the splits, or wires, of the reed that would naturally separate the ground ends must be taken out, in order to allow the doup ends to cross them in weaving; this also leaves sufficient space for the ends to spread when weaving plain instead of gauze.

56. The doups that pass through the heddles of the standard harness are fastened securely to the framework of the doup harness, generally by being sewn to a cord fastened to the frame; consequently, they can be placed in the exact position that they should occupy. It is necessary, however, to give definite instructions to the person doing this work, since, if the doups are not made to occupy a position that will bring them in direct line with the ends drawn through them, considerable chafing of both yarn and doups must necessarily follow.

It is the custom when giving particulars for the doup harness, to state exactly how much space exists between the gauze stripes, and how much space each stripe occupies, together with the number of doups necessary for that stripe. For example, 4 doup ends may be working together to form a stripe, occupying $\frac{1}{4}$ inch; then the four doups necessary for these ends will be distributed evenly on $\frac{1}{4}$ inch of the doup-harness frame. Next, there may be 1 inch of plain cloth in which no doup ends appear; consequently, this space will be skipped, then four more doups fastened to the frame, and so on until the whole is completed. In this way the harness maker will leave spaces on the harnesses to correspond with the requirements of the design. In cases where part of the doups are right-hand and part left-hand, the necessary instruction for this part of the work must also be given, so that the desired effect will be produced. A convenient method employed in preparing the doup harness is to mark off on a stick the positions of the doups throughout the width of the warp, the stick being then used as a guide in fastening the doups to the doup harness.

PILE WEAVES

CONSTRUCTION OF PILE FABRICS

INTRODUCTION

1. Cloths of the class of textiles known as **pile fabrics** are distinguished in their finished condition by having a large number of threads projecting almost vertically from the body of the cloth; this is technically known as the *pile* of the goods, from which the name pile fabrics is obtained. The pile is supported by a closely woven ground cloth, the face of which is usually entirely hidden through being covered by the pile. Pile fabrics are, of course, entirely distinct from those cloths having a napped surface produced by a finishing process of gigging, napping, or raising, such as blankets, Canton flannels, and fleece-lined goods, in which the nap is produced by loosening and brushing some of the fibers of the yarns forming the body of the cloth.

Pile fabrics are produced in great variety, some of simple structure and others involving intricate patterns and complicated interlacings of the various series of yarns. While produced in relatively small quantities, they are of great importance on account of their usefulness for various purposes or for the artistic effects that are produced. Most varieties of pile fabrics in their finished state are familiar to the average person, but their structure and design are comparatively unknown except to the more experienced designers. This is partially due to the fact that their production is not large and is confined to certain districts, and also because of the complicated structure of certain varieties

of these fabrics. To thoroughly understand them requires an excellent knowledge of cloth structure and of weaving mechanism.

The system of yarn that forms the pile of a pile fabric is spoken of as the *pile warp* or the *pile filling*, as the case may be, while the systems forming the foundation fabric are spoken of as the *ground warp* and the *ground filling*. The pile appears in different forms in different classes of goods. In some cases, it covers the entire surface of the ground fabric, appearing like a continuous brush of uniform height, as in velvets and plushes; in other cases, it forms cords with a distinct rounded formation, running lengthwise of the goods, as in corduroy fabrics. Sometimes the pile remains in a series of loops of uniform height covering the surface of the ground cloth, as in Brussels carpets, or with the same effect on both the face and back of the fabric, as in Turkish towels, although in the latter case the pile does not stand so erect nor is it so thick and close as in other pile fabrics. Still other varieties are produced by a combination of different forms of pile arranged to give a figured effect, as in mantle cloths and draperies.

The different varieties of pile fabrics may be classified in several ways, one of which is to make two divisions, one to include those fabrics in which the pile yarn is *uncut* and remains in the form of loops issuing from the body of the cloth, and the other to include those in which the pile is *cut* so as to form two individual ends of pile projecting from the face of the fabric. Since, however, this classification does not provide for those fabrics in which both cut and uncut pile is combined, it is not sufficiently definite. Another classification separates the different varieties of pile fabrics into two divisions, one of which includes those fabrics of a corduroy nature, in which the pile is arranged in cords running lengthwise of the fabric, while the other embraces those in which the pile extends uniformly over the entire face of the cloth. This classification also is not sufficiently comprehensive, since certain fancy or figured pile fabrics cannot correctly be placed in either class. Another system, and the

one adopted here, which admits of a definite classification of all pile fabrics, provides for two main classes, namely, **filling-pile fabrics,** in which the pile is formed of filling yarn, and **warp-pile fabrics,** in which the pile is formed of warp yarn.

2. In all pile fabrics, the pile yarn is uncut when the cloth is first woven. In the case of filling-pile fabrics, the cutting is the object of a special process performed after the cloth is taken from the loom. In cut warp-pile fabrics, the cutting usually takes place in the loom after a sufficient number of picks have been inserted to prevent the cut pile being pulled from the fabric; in some warp-pile fabrics, however, the pile is left uncut and standing in loops.

There is a certain similarity in warp- and filling-pile fabrics, since in each the weave is so arranged as to produce a substantial, closely woven foundation, or ground, cloth that is not disturbed during the cutting process; this serves to hold the pile in position and bind it after it is cut, so that the fabric will not fray easily or the pile be loosened from the cloth. In many filling-pile fabrics, it is customary to use only one size or quality of filling, which serves on certain picks as ground filling and on other picks as pile filling. When the ground filling is inserted in the cloth, the sheds are so formed as to cause it to interlace with the warp in such a manner as to form the ground cloth. When, however, the pile filling is inserted, all the warp is depressed with the exception of certain ends that are raised so as to allow the pile yarn to be bound to the ground cloth. The pile filling, therefore, floats over the ground cloth in long floats, the length of which depends on the length of pile desired; this is governed by the position of the ends that are raised over the pile pick to bind it to the ground cloth. The principle of construction of a filling-pile fabric closely resembles that of an ordinary backed cloth, with the exception that in the latter the extra, or backing, filling floats on the back of the cloth, while in a filling-pile fabric the extra, or pile, filling floats on the face of the fabric.

Owing to the fact that separate ground and pile warps are used for producing warp-pile fabrics, it is not customary in this case to have both the pile and ground warp of the same material, size, or quality. Usually the pile warp is a finer yarn and constructed of superior material. While it would be possible to make a warp-pile fabric on the same principle as a filling-pile cloth, namely, by allowing the warp to float on the surface of the cloth so that it may afterwards be cut in the same manner as in filling-pile fabrics, this method is seldom adopted. The usual method is to construct loops of pile by raising the pile warp and inserting a wire in the shed. The pile warp being depressed under the ground picks preceding and following the insertion of the wire results in a row of loops of pile yarn being formed across the cloth by the wire; the size of the wire governs the size of the loops. In case it is desired to make a cut-pile fabric, the top of the loop is cut with a knife either before or during the removal of the wire, while if the pile is to remain uncut, the wire is drawn out without any cutting operation, which leaves a row of loops across the fabric.

FILLING-PILE FABRICS

CORDUROYS

3. Perhaps the simplest pile fabrics are those in which the pile is formed with extra, or pile, filling; and of this class the construction of that variety known as *corduroy* is the easiest to understand. **Corduroys** are cotton fabrics characterized by brush-like cords of pile running in the direction of the length of the piece. These cords are formed by allowing certain picks of filling, called the *pile filling*, to float over the surface of the fabric, while certain other picks, called the *ground picks*, interlace with the warp in such a manner as to form a firm foundation, or ground, cloth. After the cloth is woven, the floats of pile filling are cut in such a manner as to form the series of ridges of pile running lengthwise of the cloth that is the distinctive feature of a

corduroy fabric. These ridges are rounded, with the longest pile in the center of the ridge and shorter pile on either side, so as to leave a well-defined groove between the cords; in fact, it is almost possible to distinguish the ground fabric between the ridges of pile, especially in the cheaper grades. In all corduroy cloths, it is possible to observe the ground cloth by bending the fabric so as to separate the ridges of pile.

The ground weave for this type of pile fabrics should be of simple structure, such as the plain weave, or basket or twill weaves, the latter being used when it is desired to introduce more filling into the ground cloth and thus make a closer and heavier fabric.

4. Fig. 1 shows one repeat in the ends and two repeats in the picks of a corduroy weave in which the ground is woven with the plain weave. The first pick of this weave is a ground pick, the second and third are pile picks, the fourth pick is a ground pick, and the fifth and sixth, pile picks. In this weave, the interlacings of the ground picks with the warp are shown by the filled black squares and the interlacings of the pile filling by the shaded squares. This method of showing filling-pile weaves is adopted here only for the purpose of allowing the interlacings of the pile and ground picks to be readily distinguished, and is not actually necessary, since all marked squares—whether black or shaded—represent the warp raised.

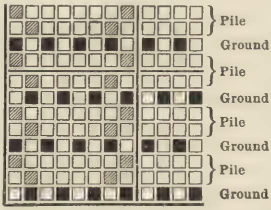


FIG. 1

In constructing weaves for corduroy fabrics, after the number of ends and picks on which the weave is to be complete have been determined, the first step in representing it on design paper is to indicate the ground picks and place on them the desired ground weave, which in the case of Fig. 1 is the plain weave. The next step is to raise certain ends of the warp over the pile picks so as to bind them to the ground cloth. Thus, in Fig. 1, on the first pile pick, which is the

second pick of the weave, the second and seventh ends are raised, while on the second pile pick, which is the third pick of the weave, the first and eighth ends are raised; the fifth and sixth picks interlace with the warp exactly the same as the second and third, respectively. Two adjacent ends are thus alternately raised over the pile picks so as to fasten them to the foundation cloth.

These two ends do all the binding, since in a corduroy the binding points of the pile filling run lengthwise of the piece, in order to produce a series of floats running in the same direction to form the cord when cut. For binding the pile filling in corduroys, 2 ends are used instead of 1 end in order to make the cord of sufficient width to cover the ground well, and also so as to make the cloth more compact by allowing the ground picks to be placed closely together, since if all the pile picks were tied by 1 end, the intersections of the pile filling would tend to hold the ground picks apart. Moreover, if 1 end were used for tying purposes, that end would be considerably strained.

Since all filling-pile fabrics are woven with a large number of picks per inch, the ground picks will be forced together by the lay of the loom in beating up the filling and lie side by side; thus, in Fig. 1, the first, fourth, seventh, and tenth picks will be forced close together and form a plain ground cloth. This will cause the floats of the pile filling to be forced to the face of the cloth and float over the closely woven ground cloth except at those points where it is bound. Thus the second and third, fifth and sixth, eighth and ninth, and eleventh and twelfth picks will be very tightly compressed between the ground picks at those points where they are depressed under a single warp end, but at all other points will float over the surface of the ground cloth, thus forming ridges or lines of float lengthwise of the goods; these ridges are known as **races**.

Fig. 2 is a section of Fig. 1 showing the interlacings of the first four picks. The first pick, which is a ground pick, interlaces with the warp in plain order. The second is a pick of pile filling that floats over all the warp except the

second and seventh ends, which are lifted, according to the weave in Fig. 1, to bind the pile. The third is a pile pick bound to the ground cloth by being passed under the first and eighth warp ends. The fourth pick of Fig. 1 is shown in Fig. 2, and is the second pick of the plain ground weave.

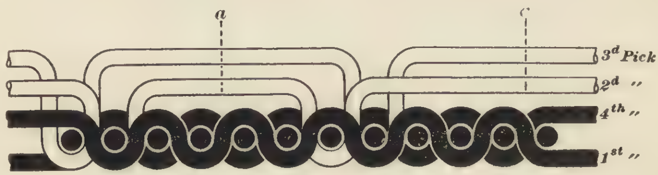


FIG. 2

If the fifth and sixth picks, which are pile picks, were shown, their interlacings would be like those of the second and third.

In order to form the characteristic corduroy cord, the races of pile filling are severed at the points of intersection with the lines *a*, Fig. 2, the severed ends rising and forming a cord the center of which will be midway between the dotted lines *a* at the point where the pile filling is bound into the cloth. As one pick of pile filling alternately floats over 4 and 6 warp ends, and the other alternately over 6 and 4 ends, after the floats are cut the length of the pile on each side of the binding point will vary slightly, and the longer

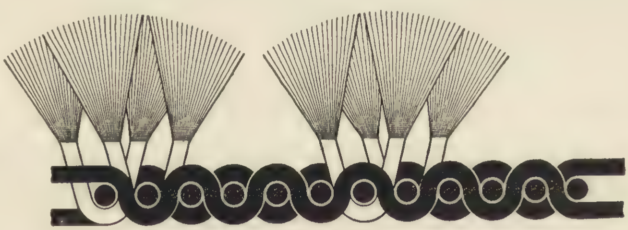


FIG. 3

pile will have a tendency to remain in the center of the cord, while the shorter pile will be on each side, thus giving the desired rounded appearance of the cord when finished. Fig. 3 shows the appearance of the section in Fig. 2 after the pile filling has been cut.

5. Cutting Corduroys.—The cutting of filling-pile fabrics is accomplished with a knife, shown in Fig. 4, having a sharp-pointed blade, on the end of which is a sheath that is brought to a point at its forward end. In operation, the point of the sheath is inserted in the race of floats formed on the surface of the cloth, shown in Fig. 2, and as the knife is pushed forwards the yarn is raised by the sheath *b* until it comes in contact with the sharp cutting edge of the knife *a* and is severed. The sheath is adjustable,

FIG. 4

in order to regulate the point at which the yarn comes in contact with the knife, so that the knife can be used to cut long or short floats of the pile filling, according to the cloth that is being made. When cutting the pile, about 2 yards of the cloth is stretched tightly on a frame and the operator, commencing at the right-hand side of the cloth, cuts each race of floats as he proceeds. The operation of cutting the pile on a filling-pile fabric is a laborious task, requiring some skill and adding materially to the cost of the fabric.

After the pile is cut, corduroy fabrics are brushed and singed in order to obtain a smooth, rounded cord, and are dyed usually dark shades of brown and drab. Corduroy fabrics possess excellent wearing qualities and are largely used for rough outdoor wear.

6. If the back of a cloth woven with the corduroy weave shown in Fig. 1 is examined, the appearance of plain cloth will be recognized. Those portions of the ground fabric between the ends that bind the pile filling are woven with the regular plain weave, but the binding ends do not interlace with the filling exactly as in a plain weave, although the difference can hardly be noticed, owing to the binding points being almost covered by the close structure of the fabric. Filling-pile fabrics that are woven with a plain ground weave are said to have a *plain back*, or, as it is sometimes termed in the textile trade, a *tabby back*. Although tabby backs are

frequently used, all corduroy fabrics are not constructed with a plain ground weave. When it is desired to produce a somewhat heavier ground cloth, a twill weave is often used for the ground weave, thus permitting more picks per inch to be inserted.

When a twill weave is used for the ground weave, it gives a distinctive appearance to the back of the fabric, which is then spoken of as a *twill back*. The weaves most commonly used for this purpose are the prunelle and cassimere twills. Another name for the prunelle twill is the *jean* twill; from this is derived the term *jeanette back*, which is used when the ground fabric of a filling-pile cloth is woven with a prunelle-twill weave. Fig. 5 shows a jeanette-back corduroy weave, the ground weave being the prunelle twill. In

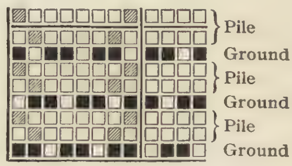


Fig. 5

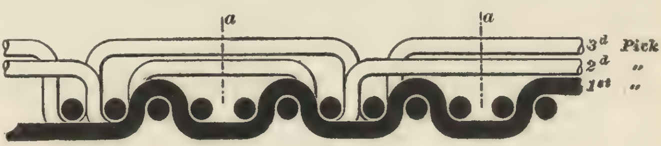


Fig. 6

this weave, 1 pick of ground filling alternates with 2 pile picks, the latter being bound to the cloth by being passed under certain warp ends in a similar manner to that employed

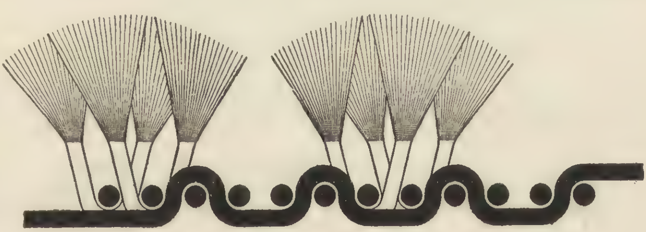


Fig. 7

in Fig. 1. Fig. 6 is a section of Fig. 5 showing the interlacings of the first 3 picks, the pile filling in this case being uncut. In Fig. 7 a section is shown of Fig. 5 in which the

pile filling has been cut so as to form the characteristic corduroy cord. Fig. 8 is another corduroy weave, but in this case the cassimere twill is used for the ground weave; this weave closely resembles the one shown in Fig. 5, with the exception that a different ground weave is used—it will produce a twill-back corduroy.

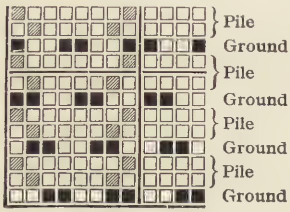


Fig. 8

In the corduroy weaves that have been shown, 1 pick of ground filling has alternated with 2 picks of pile filling, but in some cases corduroy weaves are constructed in which 1 pick of ground filling alternates with 3 picks of pile filling. Fig. 9 shows such a weave, in which the first pick is a ground pick and the next 3 picks pile picks bound to the ground cloth as indicated. The ground weave in this case is the 4-harness basket weave. Fig. 10 is a section showing the interlacings of the first 4 picks of Fig. 9; in this figure, the pile filling is shown cut so that the cord is formed as in all corduroy fabrics.

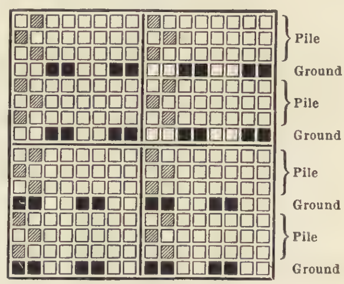


Fig. 9

In the weaves already described, each pile pick is bound to

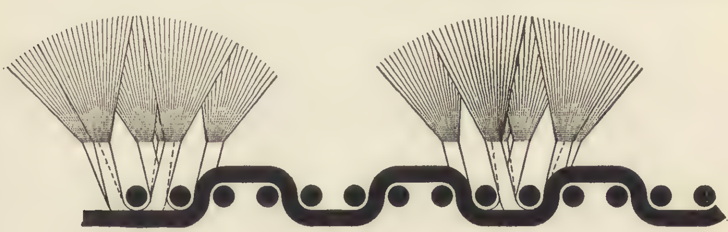


Fig. 10

the ground cloth by being passed under only 1 end of the warp, but in some varieties of filling-pile weaves the pile picks are bound more securely by being passed under one end, over

the next, and under the third, before floating, which causes the weave to require a larger number of ends in the repeat in order to obtain any given length of pile-filling float.

The proportion of pile picks to ground picks varies in different corduroy weaves, and although 2 picks of pile to 1 pick of ground is the usual proportion, these weaves are sometimes made with 2 of pile, 1 of ground, 1 of pile, 1 of ground, or 3 of pile, 1 of ground, 2 of pile, 1 of ground; and in special cases other combinations are used.

The number of ends over which the pile filling floats also affects the repeat of the weave. Those weaves already given represent the smallest floats that are generally used, but in order to make more pronounced cords it is not unusual to have the filling float over a larger number of ends—from 7 to 15, or even more.

VELVETEEN

7. Besides corduroy, in which the pile is distributed in lines running lengthwise of the goods, there is a filling-pile fabric—that known as **velveteen**—in which the pile is uniformly distributed over the entire surface of the cloth, producing a level pile that completely hides the ground cloth from view. Since the pile in this fabric is formed by an extra, or pile, filling, the name velveteen is used to distinguish it from the true velvet, which is formed with an extra, or pile, warp. As the object in a fabric of this description is to produce a pile over the entire surface of the cloth, every end at some point or points may be used to bind the pile filling; but more frequently every other end only is used for this purpose, the binding points occurring often on a twill and sometimes on a satin basis. In arranging the weave for a velveteen, the most important points to be provided for are the formation of proper races, or lines of floats, for the cutter, and a good method of binding pile picks.

The velveteen pile is cut in a somewhat similar way to the cutting of corduroy, except that the cutting knife runs diagonally across the cloth, whereas in corduroy fabrics it is run in a direction parallel to the warp. The number of traverses

to be made by the cutting knife for velveteens is much greater than for corduroys; frequently it must be run across several hundred times in order to cut the pile on 2 yards of fabric. The number of races for the cutting knife affects the expense of cutting velveteen, so that if the number of races can be reduced, the expense is lessened. The number of races, however, must not be reduced to such an extent as to produce a ridgy or corded effect, since a perfect velveteen should have an absolutely even surface. By arranging the binding points so as to produce only a sufficient number of races for the particular quality of fabric being produced, satisfactory results are obtained, and the number of traverses of the cutting knife reduced to a minimum.

8. One of the most common velveteen weaves is shown in Fig. 11, which gives four repeats of the weave. This weave is woven with 1 pick of ground filling and 3 picks of pile filling, the pile picks being tied to every alternate end of the ground fabric in twill order. The ground weave is the plain weave and the pile filling floats over 5 warp ends. The number of ends over which the pile filling floats is one of the features that govern the length of the pile on the face of the goods; thus it may float over 3 or 5 ends for a short pile, or over 7 or 9 ends for a longer pile. Fig. 12 is a section of the weave shown in Fig. 11, illustrating the interlacings

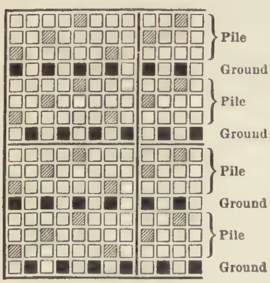


FIG. 11

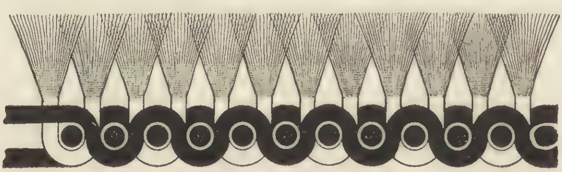


FIG. 12

of the first 5 picks; in this figure, the pile is supposed to have been cut.

Fig. 13 shows a weave for a velveteen that is very similar to the weave shown in Fig. 11, the chief difference being that in this weave 4 pile picks alternate with 1 ground pick, while in Fig. 11, 3 pile picks alternate with 1 ground pick; in this weave, also, the pile filling floats over 7 ground ends. In Fig. 14 is shown a weave for a velveteen that is similar

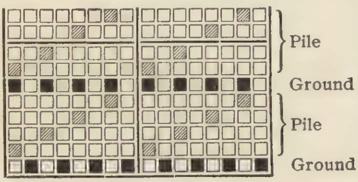


FIG. 13

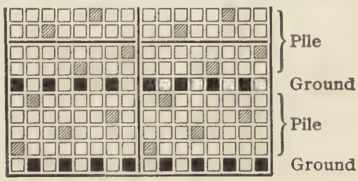


FIG. 14

to Fig. 13, in that the ground weave is the plain weave, but in this figure the pile filling is bound to the ground cloth in 8-end satin order. This design will weave better than Fig. 13, because the interlacings of the pile picks are equally distributed over all the warp ends, but it will be more difficult to cut.

If a heavy, or thick, pile on the face of the fabric is desired, the picks per inch can be increased proportionately; while if a light, or thin, pile is desired, the picks per inch can be reduced.

Velveteens, like corduroys, may be made with twills or other simple weaves for ground weaves; Fig. 15 shows a weave made in this manner. The ground is the cassimere twill and the pile picks are tied to the warp in twill order. The weave is arranged 1 pick of ground and 3 picks of pile filling.

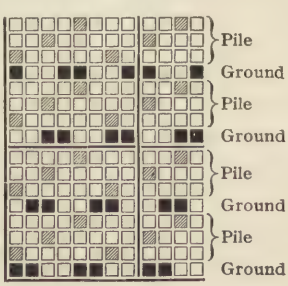


FIG. 15

9. In the velveteen weaves given so far, the pile filling, at each place where it is being tied to the ground, passes under a single warp end. By this method, however, there is some danger of the pile being pulled from the cloth in the cutting, especially if the cutting knife is a

little dull. To prevent the possibility of this happening, velveteen is often made with the pile pick interlacing with 3 warp ends, as shown in Fig. 16; that is, between each long cutting float the pile pick passes under a warp end, then over a single end, and finally under another end.

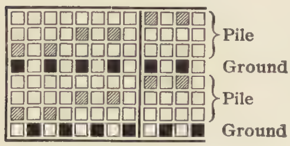


FIG. 16

Fig. 17 is a section of the weave in Fig. 16, showing the interlacings of the second, third, and fourth picks, which are pile picks, and the method of tying them into the ground; it will be seen that they are much more firmly tied by this method than when they are passed

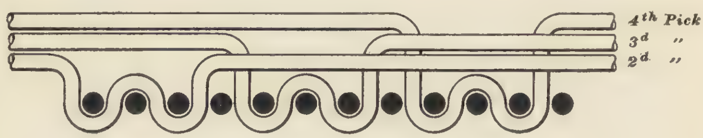


FIG. 17

under only 1 end of the warp. If it is necessary to secure the pile even more than in Figs. 16 and 17, the pile picks may be made to interlace with 5 ends of the warp instead of 3 ends.

Fabrics in which the pile is formed by an extra filling may, in general, be woven from one beam; and in cases where the pile filling is of the same yarn as the ground filling, in single-box looms. Sometimes, however, a different filling is used for the pile, in which case a box loom is necessary, and when a single pick of ground or an odd number of pile picks is placed in the cloth a pick-and-pick loom is required. In consequence of the pile filling floating on the face of the goods, a large number of picks per inch is required; in some cases, where a fine, thick pile is produced, there are as many as 400 picks. The harness and chain drafts for filling-pile fabrics are made exactly the same as for single cloth, and therefore need no further description.

10. The length and density of the pile in filling-pile fabrics may be easily altered when it is necessary to meet

some special demand. The length of the pile may be changed by allowing the pile filling to float over a greater number of ends, so that when the floats are cut the length of the pile will be increased. If, however, the length of the pile is increased and the number of picks per inch remains the same, the density of the pile will be reduced. For instance, suppose that the pile filling in a fabric was floating for $\frac{1}{8}$ inch on the face of the cloth and that the length of the floats was increased to $\frac{1}{4}$ inch; if the number of picks per inch remained the same, the density of the pile would be reduced one-half. In order to keep the same density of pile, therefore, the number of picks per inch should be doubled. A case like this may always be treated proportionately, and the number of picks per inch increased.

Whenever the fineness of the ground cloth is altered, there is a corresponding alteration in both the density and length of the pile. For instance, if more warp threads per inch are placed in the cloth, the pile picks in floating over the same number of ends will make shorter floats, which, of course, will shorten the pile. The density of the pile will be altered at the same time, since the binding points of the pile will be brought closer together. Any change in the number of picks per inch affects the density of the pile, but does not change its length.

EXAMPLES FOR PRACTICE

1. Make a corduroy weave to be picked 1 ground and 2 pile, the ground weave to be plain and the pile filling to float over 5 and 7 ends.

2. Make a section of the above weave, showing the interlacings of the first 3 picks. The pile is to be shown uncut.

3. Make a corduroy weave to be arranged 1 pick of ground and 2 picks of pile filling, the ground to be the 4-harness twill. Arrange the tying places of the pile filling so that the pile will float over 6 and 8 ends.

4. Make a section of the above weave, showing the interlacings of the first 3 picks. Show the pile picks uncut.

5. Make an original weave for a velveteen cloth.

6. Make a weave for a velveteen, the ground weave to be the $\frac{2}{1}$ twill and 3 picks of pile filling to alternate with 1 pick of ground filling.

FIGURED FILLING-PILE FABRICS

11. Figured effects may be produced in connection with filling-pile fabrics by allowing the pile to be formed on the face of the ground cloth according to a given motive. When it is not desired to produce the pile, the pile filling is allowed to float at the back of the ground fabric. In this manner any figure may be produced in pile on a plain or twilled ground.

In Fig. 18 (*a*) a motive is shown for a filling-pile figure to be placed on a plain ground cloth, while in Fig. 18 (*b*) the complete design is shown. In Fig. 18 (*a*) the shaded squares represent the method of allowing the pile filling to float on the surface of the fabric, but in Fig. 18 (*b*) the shaded squares represent warp raised over the pile filling. This design is arranged 3 picks of pile filling and 1 pick of ground; therefore, the complete pattern occupies 24 ends and 96 picks, since the motive is complete on 24 ends and 24 picks. The construction of this design should be carefully studied, since although this is a small and comparatively simple pattern, all designs of this class are constructed on the same principle. It will be noticed that where the figure occurs the construction of the design is the same as a simple velveteen weave, but where the ground of the fabric is to be plain all the warp is raised, allowing the pile filling to float on the back of the cloth, and enabling the ground picks to be forced together to form the ground fabric. This waste yarn is afterwards cut from the back of the fabric. Thus, pile is formed only where the figure occurs. Great

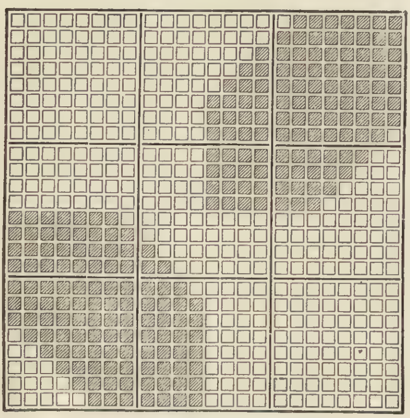
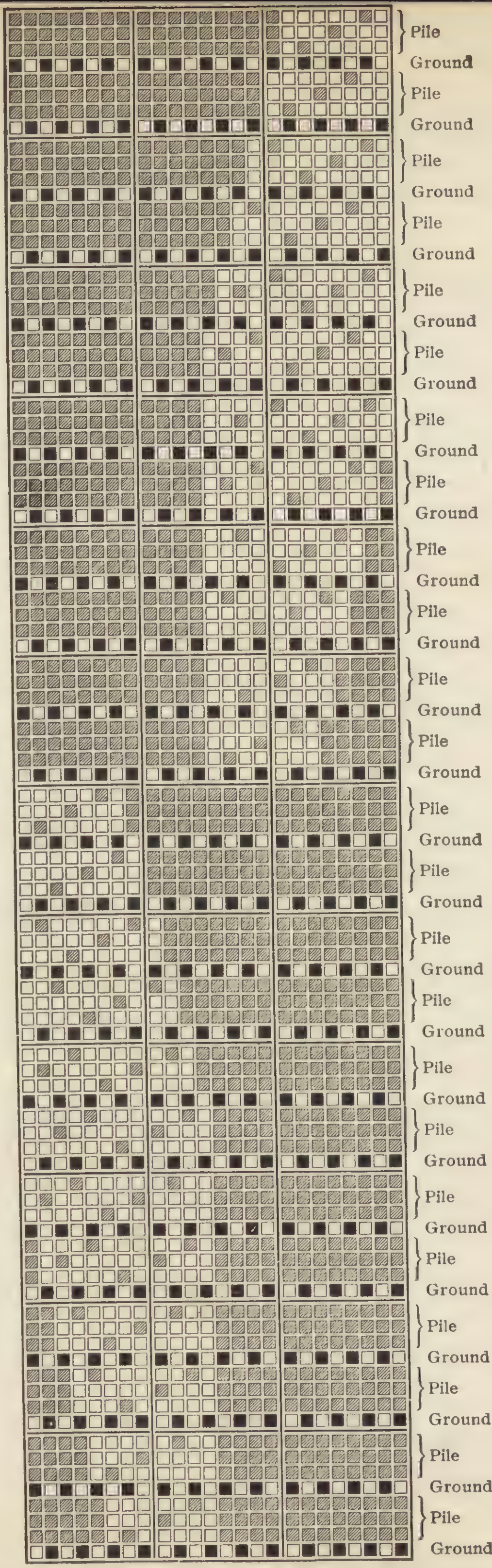


FIG. 18 (*a*)



Pile
Ground
Pile
Ground
Pile
Ground
Pile
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Pile
Ground
Pile
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Ground

FIG. 18 (*b*)

care must be taken in arranging the binding points of the pile filling where the figure occurs, so that proper races may be formed for the cutting knife, especially in the more complicated patterns.

WARP-PILE FABRICS

12. Warp-pile fabrics, although similar to filling-pile fabrics, are constructed in a slightly different manner, as the pile effect is obtained by means of an extra, or pile, warp; two warps are therefore necessary—one for the ground cloth and another for the pile. There are two effects obtained with warp pile—one in which the pile yarn is uncut and forms upright loops on the surface of the fabric, and another in which the pile is cut to form a brush-like surface on the goods; in the former case the pile is known as *terry pile*, while in the latter case a true *velvet*, or *plush*, *pile* is formed.

13. In the production of warp-pile fabrics, the pile is produced by raising the pile warp over a wire and then depressing it to interlace with the ground again. When the pile shed is formed in the loom, the wire is inserted; and as the shed closes on the wire and the lay beats up, the wire is forced up on the surface of the cloth, thus forming the loops. The pile warp should be down on the picks preceding and following the wire. It is not necessary to raise all the pile warp when each wire is inserted, since a better distribution of the pile may often be obtained by raising every alternate end of the pile warp over one wire and then raising the other ends over the next wire. The thickness of the wire regulates the size of the loops made by the pile warp, and consequently the length of the pile. Where the pile is disposed in loops, as in a Brussels carpet, the wire is smooth; but when it is cut, as in velvet, a knife at the end of the wire cuts the loops of pile when the wire is withdrawn.

In power looms, the wires are inserted automatically when the pile shed is formed and are often withdrawn automatically, although they are sometimes drawn out by the weaver,

either cutting the pile or leaving it in loops, according to whether or not there is a knife on the end of the wire.

Fig. 19 is a view of a wire knife designed to be inserted under the pile and withdrawn automatically. The knife of the wire is shown at *b*, while at *a* the portion on which the mechanism of the loom operates is shown. The wire is withdrawn by means of a hooked lever that engages with the head *a*, and is actuated by a cam placed at the side of the loom. The wires are not withdrawn immediately after being inserted in the pile shed, but are allowed to remain in the cloth until they are a short distance from the fell of the cloth, since if the wire were withdrawn immediately, the tension of the warp would pull the pile ends from the cloth if the pile was cut, or pull down the loops if it was not cut.

FIG. 19

Many of the most beautiful and costly plushes and velvets are woven on hand looms, even today, in Europe. In this case, a different method is employed for cutting the pile. The wire used is flattened or elliptical in section, and has a groove cut in it so that its section appears as shown in Fig. 20. This wire is inserted by hand when the pile shed is formed, and before it is withdrawn a knife, or *trevet*, is drawn along the groove in the wire, thus neatly severing the loops of pile. When the pile is not to be cut an ungrooved wire is inserted.

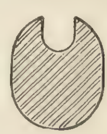


FIG. 20

14. The weave in Fig. 21 shows several repeats of a simple warp, or true, velvet arranged; in the warp, 2 ends of ground and 1 end of pile and, in the filling, 3 picks of ground and 1 shed with the wire inserted instead of a pick of filling. This weave is complete on 3 ends and 4 picks, but for the purpose of illustration several repeats are shown. If this

weave is analyzed carefully, it will be seen that the ground weave is virtually plain, but that when the pile warp is lifted over the wire, as shown by the shaded squares, 2 ground picks are placed in 1 shed, and the pile warp is raised over the wire between them. Therefore, as these 2 picks are forced up by the lay, the wire will be forced to the surface of the fabric, carrying the pile warp with it and thus forming the loops of pile, the size of which will depend on the diameter of the wire.

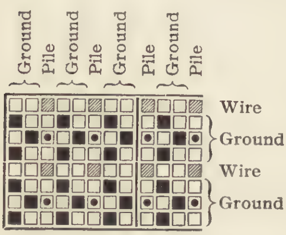


Fig. 21

The pile warp is also raised over a ground pick, as shown by the dotted squares, for the purpose of binding it to the ground more firmly. The section in Fig. 22, which shows the interlacings of the third, or pile, end of Fig. 21 with the filling and wires, illustrates this point more clearly. The wire is elliptical in section; thus, when the reed is brought against it, the wire is raised on the surface of the cloth with its longer axis vertical, thus gaining the requisite length of pile without forcing the adjacent ground picks apart. When the wires are withdrawn, terry pile will be formed if there is no knife on the end of the wire, and velvet pile if the loops are cut.

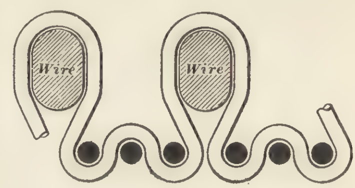
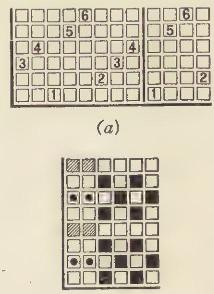


Fig. 22

Warp-pile fabrics are woven with two warps, the tension on the ground warp being fairly tight so as to give the ground the requisite firmness, and the tension on the pile warp being slack in order that the wires may be easily forced to the surface of the cloth and the pile thus formed.

15. In drafting a weave similar to that shown in Fig. 21, it is customary to separate the pile and ground harnesses in the same manner as the face and back harnesses are separated when drafts are made for double cloth, the pile warp being drawn on the front harnesses. The harness and chain drafts

for Fig. 21, constructed in this manner, are shown in Fig. 23 (*a*) and (*b*). In order that the ends may not be crowded on the harnesses, since a large number of ends are necessary for a warp-pile fabric, these drafts are shown on 6 harnesses, although they could be made on 3 harnesses.



(*a*)

(*b*)

Fig. 23

VELVETS

16. Velvet fabrics, for which Fig. 21 is a weave, are usually made with either a cotton, linen, or silk ground warp and filling and a silk pile warp; it is only in the more costly fabrics that silk is used for the ground, cotton or linen being generally employed. The ground weave is usually either the plain weave or a small rib, basket, or twill weave. The proportion of pile warp and ground warp, as well as the length of the pile, varies with different qualities of fabrics. Velvets are often classified as 2-pick, 3-pick, etc., the terms referring to the number of ground picks inserted between the wires; the design shown in Fig. 21 would be known as a 3-pick velvet.

Fig. 24 shows a very common velvet, known as the 2-pick; the warp ends are arranged 1 ground, 1 pile, and 1 ground; the ground weave is the plain weave. In Fig. 25 a similar design is shown, with the exception that the ground is a rib

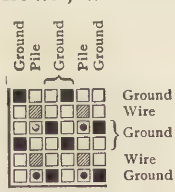


Fig. 24

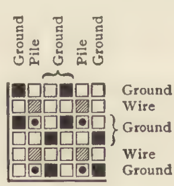


Fig. 25

weave. The method of interlacing the pile warp should be noticed in connection with these two designs. Although it was stated that the pile warp should be depressed on the pick preceding and on the pick following the wire, an

exception is sometimes made to this, as in the case of Figs. 24 and 25, where the pile warp is raised over the pick preceding the wire. However, although it is not always possible to depress the pile warp on the pick preceding the wire, after being raised over the wire it must always be depressed under the pick following, in order to force the wire to the surface. In these two designs the pile is only bound into the fabric by being passed under 1 pick; it would therefore be more liable to be pulled out than the pile in Fig. 21, which is interlaced with 3 picks. When it is desired to insert more picks per inch, a twill is often used for the ground weave of warp-pile fabrics. In Fig. 26 a weave of this description is given; the ground weave in this instance is the warp prunelle twill.

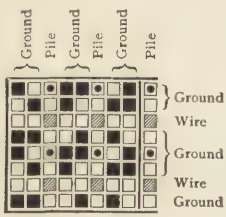


Fig. 26

17. Sometimes only a portion of the pile is lifted over one wire, while the remaining portion is lifted over the next wire, thus forming an alternate distribution of the pile, which covers the ground better in some instances. In Fig. 27 a weave for what is known as *Utrecht velvet* is shown; when the first wire is inserted every alternate end of the pile warp is raised over it, and when the next wire is inserted those ends

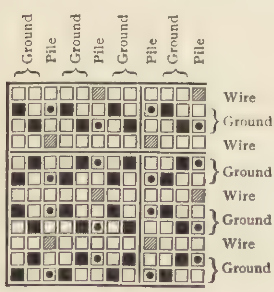


Fig. 27

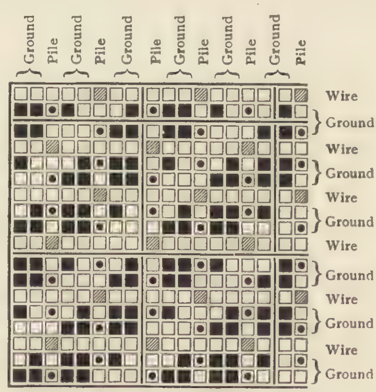


Fig. 28

that were depressed under the first wire are raised, while those that were previously raised are depressed. The ground weave in this instance may be considered as a plain weave with 2 picks in a shed or as a small rib weave. The weave in Fig. 28 is of the same type as that in Fig. 27, with the exception that the ground weave in the latter design is the $\frac{4}{2}$ twill. In order to effect the alternate distribution of the pile over the wires, it is necessary to have an even number of ground picks between the wires, while with all the pile warp lifted on each wire the pile can be best arranged with an odd number of ground picks between the wires.

Fig. 29 is a section of the weave in Fig. 28 and shows the interlacings of the first and second pile ends with the filling,

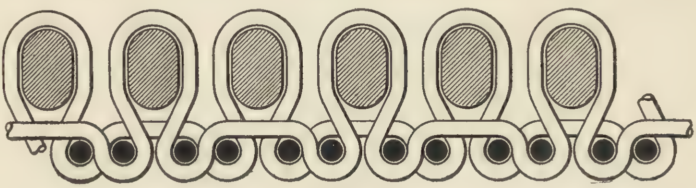


FIG. 29

and also the alternate interlacing with the wires. The interlacings of the ground ends are not shown.

The density and length of the pile in warp-pile fabrics may be altered to suit the requirements of the designer. The density may be increased by introducing more wires or by using more pile and ground ends. The length is, of course, regulated by the size of the wires inserted in the pile shed.

DOUBLE PLUSHES

18. By the system of weaving warp-pile fabrics known as the **double-plush,** two plush fabrics are formed in the loom face to face, being connected by the pile, which passes from one cloth to the other. After the filling is inserted, the two cloths are wound on separate cloth rollers, the pile between being cut by a knife, thus leaving a pile face on each fabric. The knife is set between two rollers and is

given a reciprocating motion by means of a cam at the side of the loom; thus, when the cloth is drawn forwards, the pile connecting the fabrics is neatly severed. By this method, plain velvets and plushes may be manufactured and perfect fabrics obtained, but the process does not lend itself so readily to fancy figured effects. The main advantage, of course, is the large production that may be obtained by this method.

The weave in Fig. 30 illustrates one method of producing double-plush weaves. This weave is complete on 5 ends; 2 ends are face ground ends and weave the ground for the top fabric, while 2 ends are back ground ends and produce the ground for the bottom fabric. The pile end passes from one ground cloth to the other, thus producing the pile on the surface of each cloth when they are cut apart. This weave is complete on 6 picks; 3 picks are backing picks and interlace with the bottom fabric, while 3 picks are face picks and interlace with the top fabric.

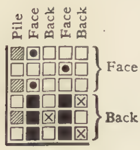


FIG. 30

In Fig. 31 a section of the weave in Fig. 30 is shown. The method of interlacing the pile warp with both ground cloths will be understood by carefully comparing the section with the weave. In order to show the interlacings of the pile warp more thoroughly, two repeats are shown in Fig. 31; the dotted line shows where the fabrics would be cut apart,

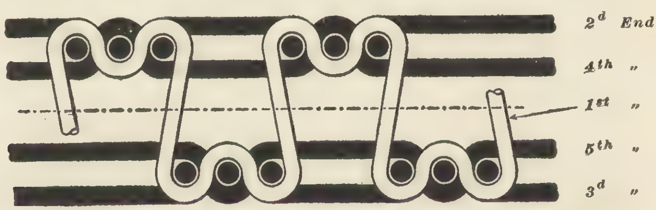


FIG. 31

thus forming two perfect plush fabrics. It will be noticed in this figure that the picks in each fabric are shown in sections of three; this is only to show the interlacings of the ends more clearly; the lay, of course, would actually beat the picks up to each other and make two closely woven fabrics.

TERRY TOWELS

19. Besides the double-plush method, which produces a cut pile on the fabric, there is another method of producing a pile fabric without the use of wires, which is commonly used in the production of what are known as **terry towels;** in this case the pile is uncut, being produced by an especially constructed loom.

These towels are produced in the loom by means of two warps—a ground and a pile warp—as is the case with all warp-pile fabrics, but the method of producing the pile is different. The ground warp is arranged with a heavy tension, while the beam of the pile warp, which is placed above the loom, is weighted very lightly, just enough friction being applied to prevent its turning too easily; this friction is regulated by a pattern chain. For 2 picks, the pile warp is held tight; but on the third the friction is taken off. The reed is so arranged that the first 2 picks are not forced up to the fell of the cloth but are left a short distance from it; the distance being regulated by the length of the pile desired. When the third pick is placed in the cloth, however, all 3 picks are forced home to the body of the cloth; and as the pile warp is lightly weighted on this pick it will be pushed out in loops more or less evenly distributed on each side of the towel. Since the ground warp is heavily weighted, it does not come forwards with the pile warp, but the 3 picks slip on it and are carried to the body of the cloth.

20. In Fig. 32 is shown a section that illustrates the interlacings of the pile warp with 3 picks of filling. This section is shown as it would appear if the filling did not slip

FIG. 32

on the ground warp, but in Fig. 33 is shown a section in which the picks have been forced home and the loops of pile warp formed on each side of the towel. The weave for

producing the standard terry towel, of which Figs. 32 and 33 are sections showing the interlacings of the first and third, or pile, ends, is shown in Fig. 34 (*a*). The harness draft with the pile warp drawn on the first two harnesses is shown

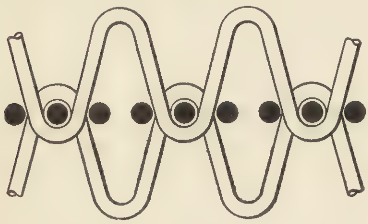
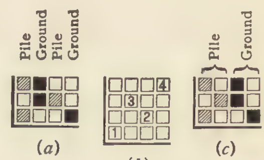


FIG. 33



(*a*) (*b*) (*c*)

FIG. 34

in Fig. 34 (*b*), while in view (*c*) the corresponding chain draft is shown. It should be noted that the ground ends in Fig. 34 (*a*) are interlaced with the picks situated between the upper and lower pile loops to prevent the filling from

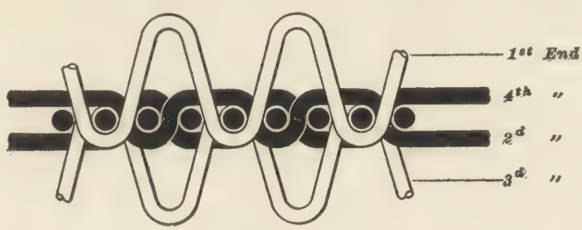
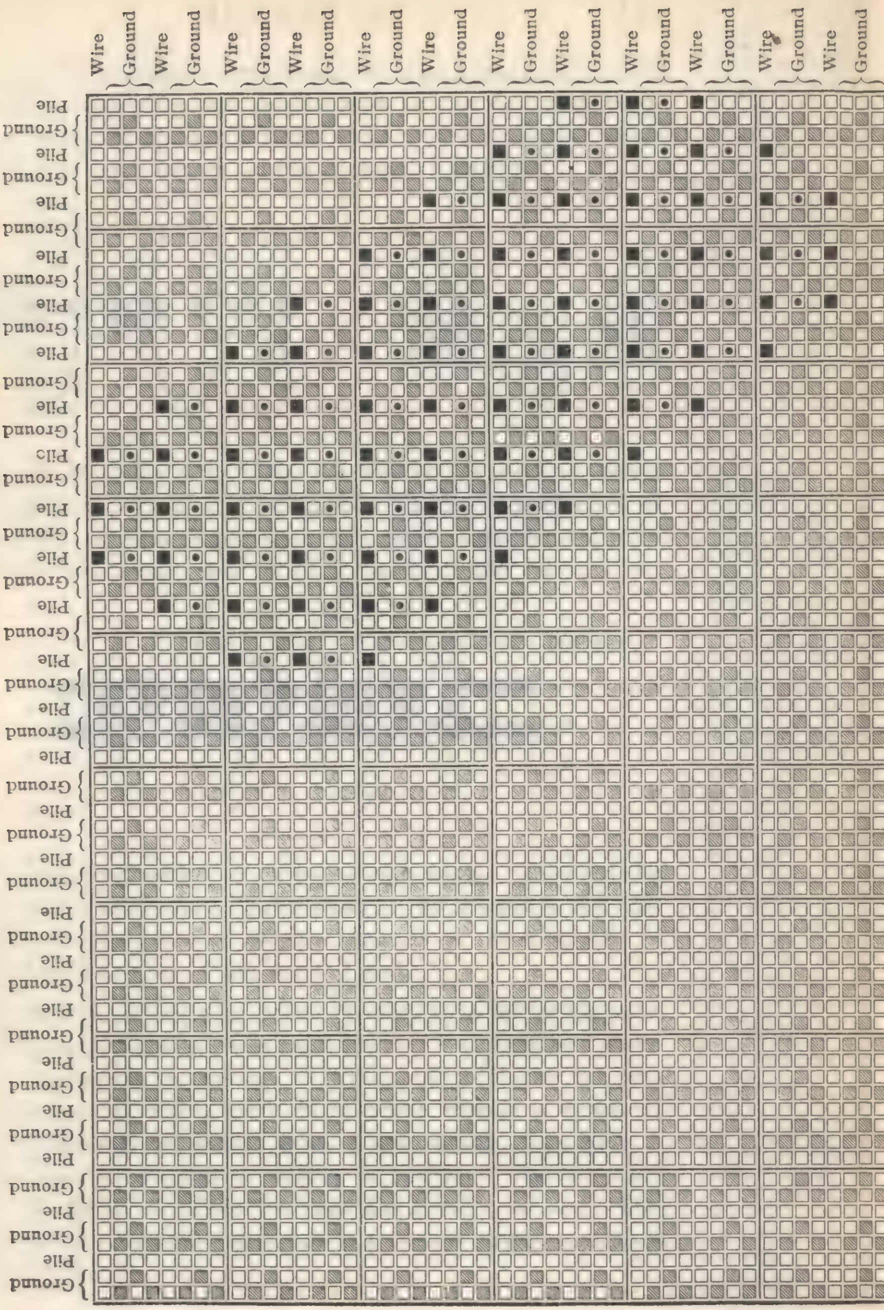
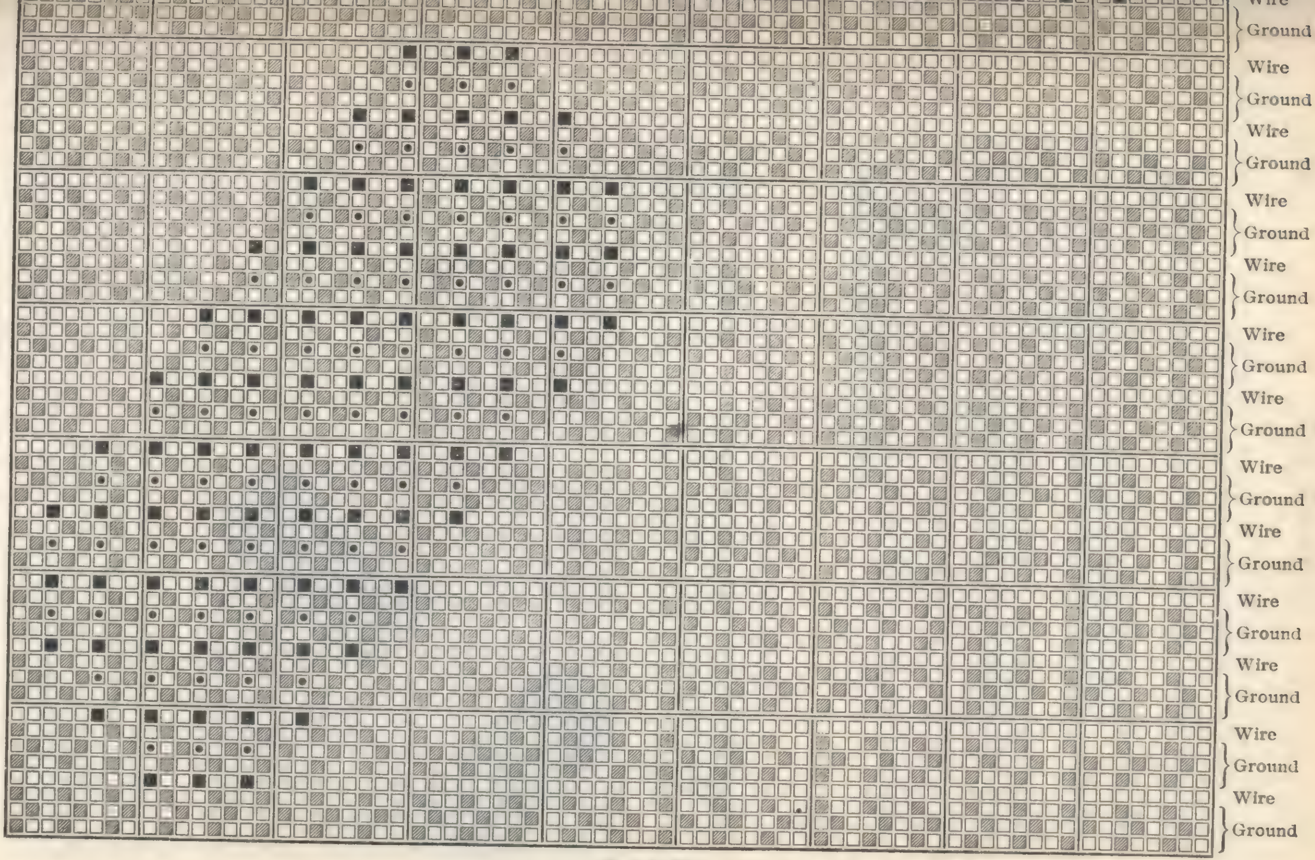


FIG. 35

being forced out with the loops of pile warp. This will be more clearly understood by referring to the section in Fig. 35, which illustrates not only the interlacings of the pile ends in Fig. 34 (*a*), but also of the ground ends.

21. It must always be borne in mind that the production of terry towels requires a special loom. These looms often have attachments by means of which the pile can be produced as desired, since there is in some towels a space at each end devoid of pile. Most towel looms also have a fringing motion, so that no filling is placed in the warp for a space of about 6 inches between the towels, so that when the towels are cut apart each has a fringe 3 inches in length at either end.


Wire
Ground
Pile



Wire
Ground
Wire
Ground
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Wire
Ground

FIG. 36 (b)

EXAMPLES FOR PRACTICE

1. Make a section showing the interlacings of the first 3 ends of Fig. 24.
2. Make a velvet weave having the $\frac{2}{2}$ twill for a ground weave. Employ the alternate system of raising the pile warp.
3. Make a section of the weave in Fig. 27 showing the interlacings of the third and sixth ends.
4. Make a weave for a warp-pile fabric, employing the $\frac{3}{3}$ twill as a ground weave and raising the entire pile warp for the insertion of the wires.
5. Make a section of the above weave showing the interlacing of the pile warp.
6. Make harness and chain drafts for Fig. 28, the pile warp to be drawn on the front harnesses.

FIGURED WARP-PILE FABRICS

22. Figured warp-pile fabrics are constructed in many ways; and in many cases, when constructed with elaborate patterns and expensive yarns, rank among the most costly fabrics woven. A simple method of producing a figured warp-pile fabric is to produce a figure in pile, either cut or uncut, according to a given motive, on the surface of an ordinary fabric. This is performed in a manner similar to that employed in producing a filling-pile figure, except that the warp-pile construction is used for the figure instead of the filling-pile. In Fig. 36 (*b*) is shown a design of this description; it is arranged 2 ends of ground and 1 end of pile in the warp, and 3 picks of ground and 1 shed for inserting the wire in the filling. The pile warp is depressed under both

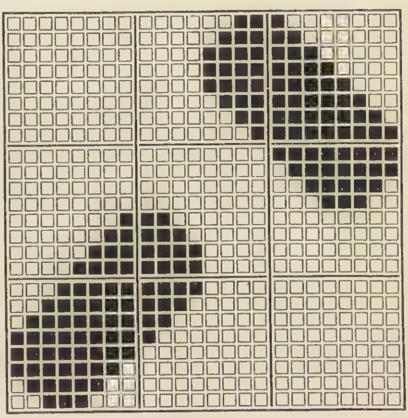

FIG. 36 (*a*)

the ground picks and the wires, except where it is desired to have the figure formed in pile; in order to show the design more clearly, the ground is indicated by shaded squares and the pile by solid black squares. The motive for this design is shown in Fig. 36 (*a*).

The ground weave used may be considered as a small rib weave or as a plain weave with 2 picks in every alternate shed. The pile warp is raised to form the figure in the same manner as in Fig. 21, and since the ground weave is also the same, the construction of the figure is really a true velvet; the ground weave only appears on the ground of the design, the pile warp floating underneath when not used to form the figure. This waste yarn is afterwards cut off in the finishing of the fabric.

23. Tapestry Carpets.—What is known as tapestry carpet is one of the simplest of figured warp-pile fabrics. Its construction is very similar to an ordinary warp-pile fabric with the exception that an extra warp is used for thickening and strengthening the fabric. The loops of pile warp are uncut and the entire surface of the fabric is uniformly covered with the pile. The pattern is produced by printing the design on the pile warp so that it will be formed by the pile on the surface of the cloth. When this pattern is printed, due consideration must be given to the take-up of the pile warp, according to the length of the pile being formed. If this item is known, it is comparatively easy to print a certain length of pile warp a certain color, so that the pile will be formed of that color for a certain distance in the cloth, and then change to another color, according to the pattern. It is not possible, however, to gauge the length of printed yarn with exact accuracy, since there are so many disturbing factors, as the take-up, length of pile, etc.; consequently, there is a certain indefinite or misty appearance to the pattern, which is one of the distinguishing features of a tapestry carpet.

The structure of the cloth itself is comparatively simple, as shown in Fig. 37, which is a design for an ordinary

tapestry carpet. This weave is complete on 4 ends and 6 picks. The ends are arranged 2 ground, 1 center warp, and 1 pile warp, while the picks are arranged 2 ground and 1 shed for inserting the wire. The center warp, which is simply a wadding warp, passes between the ground picks and does not interlace with the fabric; this is accomplished by depressing every other ground pick under the center warp; the pile warp is raised on this pick. The center warp has the same function in this fabric as a system of wadding yarn in a backed or double cloth. The construction of Fig. 37 will be understood by comparison with Fig. 38, which shows the interlacings of several repeats of the weave.

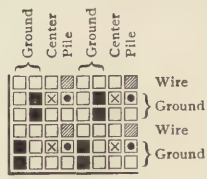

Fig. 37

The designing of a tapestry carpet is a comparatively simple matter, as the weave has nothing to do with the pattern. These goods are generally made 27 inches wide and contain 216 pile ends. The pattern is first painted out

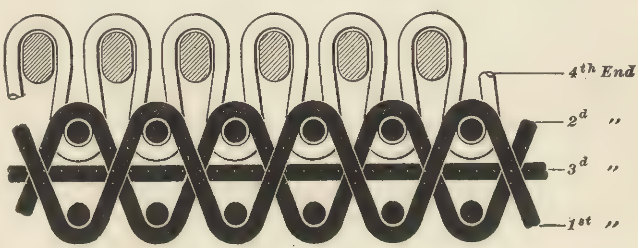

Fig. 38

in solid color on a sheet of design paper containing 216 ends, or 27 squares with 8 ends in a square, and then printed on the pile warp.

24. Brussels Carpets.—The structure of a Brussels carpet is entirely different from that of a tapestry carpet, and in its production the designer is allowed the widest scope of taste and ingenuity, while the patterns that are produced are brilliant and sharply defined. In this fabric, the pattern is formed by lifting solidly colored pile threads

to form pile on the surface of the fabric as required to make the pattern, each pile-warp end remaining in the interior of the fabric when the pattern does not call for its color on the surface. In a Brussels carpet the ground, or, as it is sometimes called, the *binder warp*, is woven from a beam, but the pile ends, owing to the difference in their take-up because of their varying interlacings with the wires, are each wound on separate spools, which are placed in frames. These spools are arranged so that friction can be applied to them in order to obtain the necessary tension of the pile ends.

The terms *3-*, *4-*, *5-*, and *6-frame carpets* refer to these frames in which the spools of pile warp are placed and designate the number of colors in the pattern of the carpet, since generally only one color is placed in each frame. The creels, or frames, that take the place of beams also denote the number of pile ends in the fabric, since each frame is designed to hold 256 spools, each carrying 1 end of the pile warp.

The complicated interlacings of the pile ends in a Brussels carpet require the use of a jacquard to produce the proper sheds. The reeding of the fabric is controlled by the colors or frames of the pile warp; thus, if a 3-frame carpet is being made, each dent will contain 5 ends, 1 end of each color of pile warp and 2 ground ends; if a 5-frame carpet is being made, each dent will contain 5 pile and 2 ground ends.

In weaving, a row of loops is formed across the cloth at the insertion of each wire, for which purpose a given number of pile ends are raised on each pick; in this case 256 ends are raised. The pile threads that are not required for the pattern are disposed in the body of the cloth as wadding, or thickening, ends. The bulk of the fabric, therefore, in a Brussels carpet is made of as good yarn as the face and is not obtained by an extra thickening warp of cheaper material, as in a tapestry carpet.

The ground weave that is used for these fabrics is the 4-harness basket $\frac{2}{2}$ so arranged that 2 successive picks are placed in a shed, but separated by the pile warp. This will be understood, as will also the statement that the pile

warp lies in the body of the fabric except when wanted on the face, by referring to Fig. 39, which is a section of a 3-frame Brussels carpet showing the 2 ground, or binder-

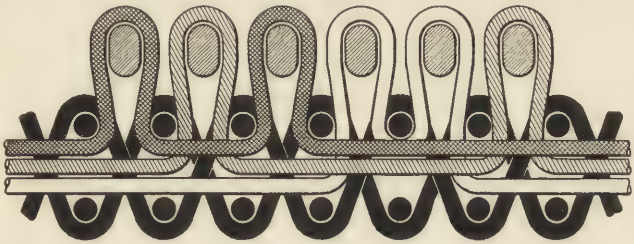

FIG. 39

warp, ends and the 3 differently colored pile-warp ends. The ground picks are alternately passed over and under the pile ends, so as to bind them into the cloth.

25. The method of producing designs for Brussels carpets is quite simple. The pattern is first painted in solid color on design paper, 3 colors being used for a 3-frame carpet, 4 for a 4-frame, etc. The design is then made, being dressed 2 ends of ground and 3 ends of pile for a 3-frame, or 4 ends of pile for a 4-frame, etc., and being picked 2 picks of ground and 1 shed for the wire. The pile warp is raised over each wire according to the previously prepared and painted pattern. To illustrate the method of making the weave for a carpet of this description, as it would be impossible to give a large flowered design here, let it be supposed that Fig. 40 represents a small portion of a large pattern for a 3-frame Brussels carpet.

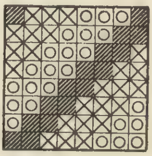

FIG. 40

In this figure, the different marks represent 3 colors of pile warp with which the design is to be formed. As a 3-frame carpet is arranged 2 ground and 3 pile, 40 ends will be taken to weave the color effect, and as these fabrics are picked 2 of ground and 1 shed for the wire, 24 sheds will be required to form the pattern; 16 sheds are for the insertion of the ground picks and 8 sheds for the wires.

Fig. 41 shows the complete weave for the effect shown in Fig. 40 arranged for a Brussels carpet. As the weave is for a 3-frame carpet, it is arranged with 3 pile ends in a section, each section being separated by 2 ground, or binder-warp, ends. The different marks on the pile ends denote the different colors, corresponding to the marks in Fig. 40. If the lifting of these pile ends over the wires is carefully noted, it will be seen how the design in Fig. 40 is formed in

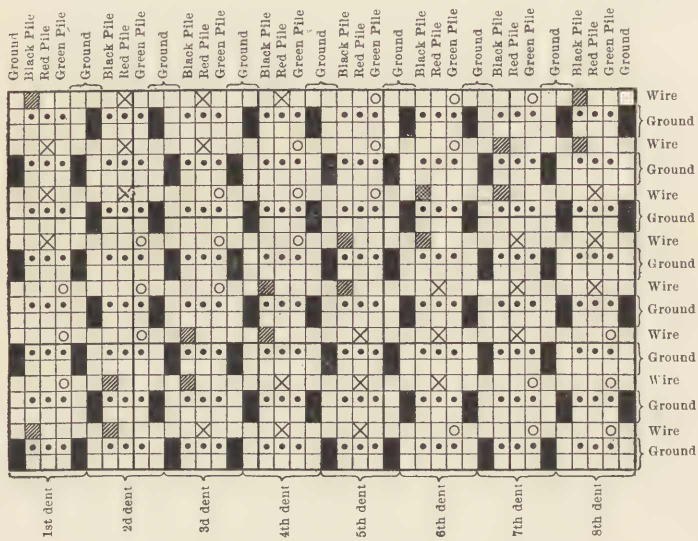

Fig. 41

pile in Fig. 41. For instance, suppose that the shaded squares in Fig. 40 represent black, the crosses red, and the circles green. On the first pick of Fig. 40 there are 2 black, 3 red, and 3 green. By referring to Fig. 41 it will be seen that this is exactly the manner in which the pile is formed over the first wire. The pile is lifted over the second wire according to the second pick of Fig. 40, and so on.

A 4-frame carpet is designed in the same manner as a 3-frame carpet, except that 4 colors and 4 pile ends are used. In a 3-frame carpet one-third of the pile warp is raised over each wire, and in a 4-frame, one-fourth is raised. The ends that are raised may be of any color, according to the design.

The other two-thirds or three-fourths of the pile ends, as the case may be, lie embedded in the body of the fabric, as explained in connection with Fig. 39. In order that these ends shall pass to the center of the fabric only and not to the back it will be noticed, by the dot marks, that all the pile ends are lifted on every alternate ground pick, thus throwing 1 ground pick on the back of the cloth to cover the pile warp.

26. What are known as **Wilton carpets** are constructed in practically the same manner as a Brussels carpet, except that in the former the loops of pile are cut, while in the latter they remain uncut. The pile warps in carpets are generally made of worsted.

VARIETIES OF PILE FABRICS

27. The leading features that produce differences in pile fabrics and, consequently, the use of different names are the material or materials used in each fabric—including the material used for the ground warp, the material used for the ground filling, and the material used to form the pile—the length of the pile, and the appearance of the back of the fabric, in addition to the weave used, the series of threads that form the pile, and the mechanisms employed for forming and cutting the pile. Four classifications of pile fabrics are commonly made from the appearance of the pile on the fabric—*fustian*, *velvet*, *plush*, and *terry*.

28. **Fustian** is a general term that has long been used and includes all the heavier filling-pile fabrics of the corduroy style, also embracing velveteens. Fustians are usually understood to be heavy cotton fabrics with a short pile, and besides the regular corduroys and velveteens include fabrics of a similar nature frequently known by special names, such as round-top cords, constitutional cords, cable cords, thickset cords, etc.

29. Velvets and plushes are distinguished by the relative length of the pile; the weaves, and in some cases the materials used, are similar, but silk fabrics having a smooth pile surface with a pile not exceeding $\frac{3}{16}$ inch in length are known

as velvets, while plush fabrics have a pile exceeding this length. A true velvet not only has this short pile, but is composed of silk alone and is a warp-pile fabric. Like many other words applied to textile fabrics, the term velvet has been misapplied, and consequently fabrics with a silk ground warp and cotton ground filling, or even with a ground of both cotton warp and filling, or linen warp and filling, etc., are sometimes spoken of as velvets. For this reason it is not sufficient to use the word velvet alone when describing a fabric manufactured exclusively of silk, but the term *silk velvet* should be used and only applied to velvets that are entirely manufactured of that material. When the ground is composed of cotton or linen it should be spoken of as a cotton-backed velvet or a linen-backed velvet, respectively.

Plush fabrics are manufactured in great variety, the pile varying in length but in general being of greater length than in velvets. The pile yarn of a plush fabric is generally silk, worsted, mohair, or some other animal fiber, while the ground fabric may be cotton, linen, or jute, which is used not only to cheapen the fabric, but to give it the required stiffness and strength.

Among the various kinds of plush may be mentioned those intended to imitate the skins of animals—such as sealskin plush, made with a pile surface of silk, imitation dogskin, made with a curled pile, etc. Mohair plushes are woven with a cotton, linen, or jute ground cloth, while the pile is formed of yarn spun from mohair. Silk plushes are made with a silk pile; the ground cloth is usually composed of cotton.

30. Uncut warp-pile fabrics, whether woven with wires or not, are called terry fabrics. Strictly speaking, the term originated with the warp-pile fabrics woven with a wire, but owing to their similarity certain towel fabrics that are woven by a special loom without wires are also classified as terry. The word terry is not applied to uncut fabrics of the filling-pile class, such as those woven on the fustian principle but used without being cut; these are simply spoken of under the trade name or as *uncut fustians*.

COLOR IN TEXTILE DESIGNING

(PART 1)

PRINCIPLES OF COLORING

THEORY OF COLOR

1. Many theories of light and color phenomena have been advanced from time to time by eminent artists and scientists, but while many of these seem to be based on fundamental laws, there has been much disagreement. It may be safely stated, therefore, that at the present time there is no universally accepted theory of color or system of color nomenclature.

2. Light.—The great majority of bodies emit no light of themselves and are therefore known as **non-luminous bodies;** but some, as for instance the sun, have the property of emitting light and are therefore known as **luminous bodies.** Luminous bodies, as the sun, or a gas or electric light, etc., are visible because of their own luminosity, but non-luminous bodies are visible only because of the property they have of reflecting the light that falls on them from luminous bodies. This is proved by the fact that the eye is unable to see non-luminous bodies at night or any other time when they are not illuminated by natural or artificial means.

White light, which is considered as pure light, is composed of all the colors found naturally or made artificially. If a

beam of white light is allowed to pass through a glass prism, the light is decomposed, or separated, into colors. If these colors are allowed to fall on a screen in a room that has been darkened, a beautiful band of color will be produced. This band of color is known as the **solar spectrum** and contains every gradation of pure color, but for convenience the following division is usually made, the colors being given in the order in which they are arranged: violet, indigo, blue, green, yellow, orange, and red.

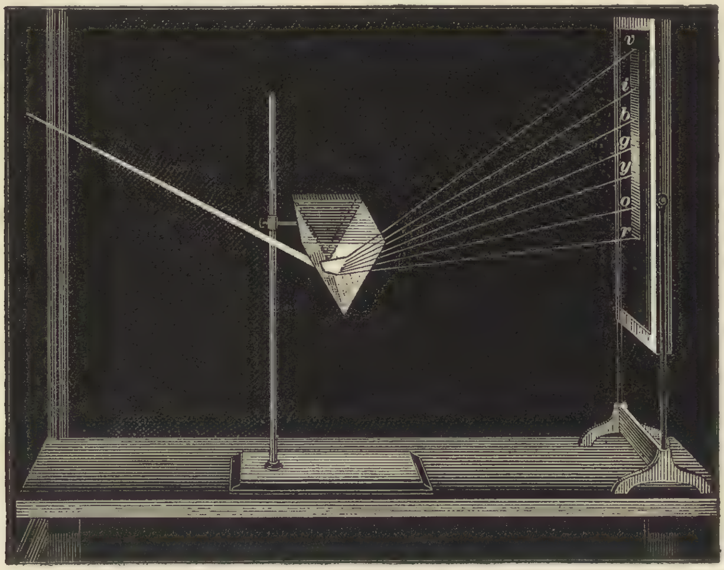

Fig. 1

A simple arrangement for the dispersion of white light into its component parts is shown in Fig. 1. A beam of white light is admitted into a darkened room through a hole in a shutter, and passing through a glass prism, is decomposed so that a spectrum is thrown on a screen. The positions of the various colors of the spectrum are indicated on this screen, in Fig. 1, by their initial letters. The decomposition of the white light is due to the refractive power of the prism. As some colors are refracted to a greater degree than others,

the light is divided into its component colors, each of which assumes its proper relative position in the spectrum. It will be noticed that the red light is refracted, or bent, from its true course the least, and the violet the most.

The seven spectrum colors are known as the *prismatic*, or *primary*, colors. Sometimes the spectrum is so divided as to make only six primary colors, the indigo being left out, as it is considered by some to be only a gradation of the blue. Red, yellow, and blue are sometimes considered as the *primary spectrum* colors, and orange, green, and violet as *secondary spectrum* colors.

The **pigment theory** of color is the one that is made use of industrially; it is based on the assumption that there are three primary colors—red, yellow, and blue—that are independent and separate pigments, differing widely from each other. These pigments are made as nearly like the spectrum colors as possible, but it is impossible to manufacture a pigment that will exactly match a spectrum color. With these three pigments and the passive colors black and white, any color, hue, shade, or tint may be produced by proper admixture.

CLASSIFICATION OF COLORS

3. Definitions.—All colors are divisible into two classes; namely, *simple*, or *primary*, colors and *compound* colors.

Simple colors are those that cannot be split up into other colors; in other words, they are fundamental colors, the term being practically synonymous with primary colors, and in the pigment theory includes red, yellow, and blue.

Compound colors are those that are obtained by mixing two colors together. There are two important classes of compound colors; namely, *secondary* and *tertiary* colors.

The **secondary colors** are produced by mixing primary colors, and consist of orange, green, and purple. Orange is obtained by mixing red and yellow. Green is obtained by mixing yellow and blue. Purple is obtained by mixing blue and red.

The **tertiary colors** are russet, citrine (or citron), and olive, and are each composed of two secondary colors. Russet is obtained by mixing orange and purple. Citrine is obtained by mixing orange and green. Olive is obtained by mixing green and purple.

NOTE.—This color theory is not absolutely satisfactory to many color experts, but is the one most generally accepted from an industrial point of view.

A **pure,** or **full, color** may be said to be an unadulterated color; that is, the most intense expression of a color without any addition of black or white.

A **broken color** is one produced by the mixture of two or more pure colors.

While black and white are not really colors, yet since they are used in producing shades and tints of colors, they are often spoken of as colors. The term **passive colors** has therefore been suggested for these two colors, together with silver, gold, and very gray colors, but this term is very indefinite, as is also the term **neutral colors,** which is sometimes used.

A **shade** is a pure color mixed with black.

A **tint** is a pure color mixed with white.

The **tone** of a color is an expression that, in the strict consideration of color, is confined to the shades and tints of a full color. The pure, or full, color is known as the normal tone of that color. Tone is sometimes considered as referring to the combined effect of several colors placed in juxtaposition, or to the general effect of a single color. In either case reference may be had to the prevailing tone, or to such qualities as luminosity, purity, warmth, shade, tint, etc. For instance, it may be said of one color combination that its tone is cold, of another that it is warm, etc. Or, a single color may be spoken of as being a deep tone of green, a warm tone of red, a bright tone of orange, etc.

The **hue** of a color may be said to be that color mixed with a small amount of another color; thus, an orange hue of red is made by adding a small amount of orange to a pure red. The term hue is sometimes used to refer to that quality

which distinguishes one color from another, be they primary or compound. For instance, red differs in hue from green, yellow from orange, etc.

Red, orange, and yellow, and combinations in which they predominate, are known as **warm colors** because of their great luminosity.

The term **cool colors** is somewhat indefinite, but is generally considered to include green, blue, and violet, and color combinations in which they predominate.

Theoretically, the **complement** of a color is a color that, when mixed with it in equal proportions, will produce white. While this is possible to accomplish with spectrum colors by means of mirrors and lenses, it is impossible with pigments, owing to the imperfection of the colors. As white light is the sum of all colors, if any color is taken from it, the remaining color is the complement of that color. An interesting experiment in this connection may be performed by gazing intently at a red spot on a white surface for two or three minutes or until the eye becomes fatigued. If the eye is now turned from the red spot toward a white surface, a faint tint of bluish green is seen. This is called the **accidental color** of red, and is practically the same thing as its complementary color.

There are many pairs of complementary colors, but the simplest ones, which are most frequently met with, are as follows: The complementary color of red is a bluish green; of yellow, ultramarine blue; of violet, greenish yellow; of orange, deep blue; of green, reddish violet.

4. Color Sensation.—As already explained, pure light, as it comes from the sun, is white. A colored light is a light that is incomplete, that is to say, it is lacking in one or more of the colors that constitute white light. It may therefore be said that colored light is the result of subtraction. For instance, if we perceive a red light, it is to be supposed that the other principal colors (blue and yellow) that, combined with red, produce white light, have been removed from the white light and that red is all that remains. Similarly, if a

green light is visible, we may conclude that red light from some cause has been withheld. In other words, whatever color is visible is a result of its complementary color being subtracted from pure white light.

It should be remembered that color does not exist in and by itself, but is simply a matter of sensation, that is, an impression produced on the optic nerves of the eye. If, therefore, the eye is not affected by any light it cannot perceive any color.

An object painted white is not in itself really white, but appears so because the paint with which it is covered has the property of reflecting nearly all the light it has received from the sun. Whatever quantity of light that has not been reflected is absorbed by its surface. An object painted black appears black because nearly all the light it receives is absorbed by it. For that reason it is unable to send any, or but little, light to the eye, and the latter cannot be affected by it, or only to a very small extent.

It is not to be supposed that color is a quality that a substance retains under all conditions and that is inseparable from it. If such should be the case, an object, for instance, painted green, should always remain green, even when in the dark or when exposed to other than white light. We have seen that it can appear green only when green is contained in the light to which it is exposed. The paint with which it is covered serves simply the purpose of absorbing all but the green rays, which are reflected. This can easily be proved if we expose it to a very strong light from which the green rays have been removed, as for instance, by letting the light pass through a red glass. In this case the object will be unable to send out green rays because none have been received, and it will therefore appear black.

It is a familiar fact that it is impossible to judge the true values of colors when seen with artificial light. The reason for this is the same as that just given. They are exposed to light that is lacking in certain rays, and the objects are therefore unable to reflect all the colors that would be reflected under normal conditions. With ordinary gas light, greens

may appear blue, and under a Welsbach burner reddish tints may lose their red, because this light is deficient in red rays.

5. Harmony.—Two colors may be said to harmonize when they produce a pleasing effect in juxtaposition or are

Color Pairs	Modification by Contrast
Red	Inclines to violet
Orange	Inclines to yellow
Red	Inclines to violet
Yellow	Inclines to greenish yellow
Red	Becomes more brilliant
Green	Becomes more brilliant
Red	Inclines to orange
Blue	Inclines to green
Red	Inclines to orange
Violet	Inclines to blue
Orange	Inclines to red orange
Yellow	Inclines to greenish yellow
Orange	Inclines to red orange
Green	Inclines to bluish green
Orange	Inclines to yellow
Violet	Inclines to blue
Yellow	Inclines to orange
Green	Inclines to blue
Yellow	Becomes more brilliant
Blue	Becomes more brilliant
Green	Inclines to yellow
Blue	Inclines to violet
Blue	Inclines to green
Violet	Inclines to red
Greenish yellow	Becomes more brilliant
Violet	Becomes more brilliant

used together in suitable proportions in a design. Colors that do not harmonize when associated together produce effects that are displeasing to the eye.

6. Contrast.—If two colors are placed side by side or associated in a design, the eye will no longer see the same tone of either color, because each becomes modified by its adjacent color. The effect of contrast is one of utmost importance to textile designing, since the designer should know what effect will be produced when two colors are placed together in a fabric. For instance, if red and blue are used in the fabric, the red will appear to be an orange red and the blue a green blue, the true tone of each color being modified by contrast with the other.

7. The preceding table, prepared by a well-known color expert, shows the modifications of various colors when combined with another color. From this table, it will be seen that, in general, if two colors are placed together, each appears to be tinged with the complementary color of the other.

ATTRIBUTES OF COLORS

8. For want of a better word, the term **attributes of a color** is applied to certain distinctive qualities and properties of each color that govern its appropriateness for certain purposes.

9. Red.—Red, orange, and yellow have been classified as warm colors, and of the three it may be said that red is the most aggressive. Red is a very useful color to the textile designer, but, owing to its strength, must be applied with care to conventional fabrics where quiet, subdued effects are desired. Care must be taken in applying not only red but any primary color in its full strength, on account of the vivid effects obtained from the use of unadulterated colors. Primary colors are therefore but little used in textile fabrics, especially in men's wear and other fabrics where quiet effects are desired. Red, when used with care, imparts a bright, clean appearance to a fabric. It is used largely in printed fabrics and to some extent in piece-dyed goods for women and children's wear. As a color for forming spots on men's vestings and also on dress goods, red is largely used; but in

conventional men's wear it is not often applied except as a double-and-twist yarn, being usually twisted with a black thread. The darker shades of red are sometimes used as the ground of fabrics, but excellent results are difficult to obtain except in carpets and oriental effects. Tints of red are quite extensively applied in connection with vestings, silk neckties, ribbons, dress fabrics, buntings, etc. In the ordinary run of woolen and worsted fabrics, however, especially in the men's-wear trade, red or its derivatives are but sparingly employed.

In using red in combination with other colors, great care should be taken not to destroy the harmony of the design by using too much red or a tone that is too strong and brilliant. Very pure and warm tones of red are better employed in piece-dyed goods than in combination with other colors, although brilliant reds do not produce bad effects with the passive colors black and white, if used in suitable proportion.

10. Yellow.—This is a very vivid and bright color, although it does not possess the strength and warmth of red. Yellow may be said to be the most luminous color and has a great tendency to produce lustrous effects. The vivid brilliance of this color necessarily limits its application to textile fabrics, although it is a useful color for fancy threads and for overchecks in complicated plaid patterns. It also finds a limited use in oriental fabrics and their imitations, carpets, ginghams, and to some extent in woolen blankets. Care must be taken when using yellow in textile fabrics to limit the quantity used. It is rare that a large quantity of this color will produce harmonious results, yet if used in small quantities it is useful in brightening the fabric, especially in plaid designs, in which it is principally used in the ordinary run of designing. It is seldom that yellow or any tone of yellow is used for piece-dyed goods, but this is occasionally met with in silk fabrics.

11. Orange.—This color, like red, is vivid and strong, and is second only to red in warmth and strength. The use of orange for the great majority of textile fabrics is limited;

it may be used, however, in a manner similar to yellow, and is also a very useful color for fancy twist yarns, being often twisted with black or white yarns. Orange is very similar to both red and yellow, and is a very lustrous color, although not to such an extent as yellow. The luminosity and vivid character of orange makes it retain its individuality when used in combination with almost any color, and it is but little affected in tone by either light or dark grounds.

12. Blue.—Blue, being a primary color, is strong and distinctive, but unlike red, which is warm and aggressive, blue is cold and retiring, and for this reason is of value in producing quiet effects, which are still strong and pronounced. Blue is one of the most useful colors in textile fabrics and has always been highly esteemed. The ancients were particularly fond of this color, and robes of blue and purple were symbols of the highest rank. Pure blue has a certain aspect of freshness that is readily imparted to fabrics into which it is introduced. This quality is sometimes called the *bloom*, a term that is only used in this connection to indicate freshness and force of coloring. Dark shades of blue are largely used for the ground of fabrics and also in piece-dyed goods, while the lighter shades are useful for figures and spots, as well as for light-colored silk fabrics, ginghams, plaids, and many other dress-goods fabrics. Its property of coldness makes blue a useful color for subduing fabrics that would otherwise be too brilliant and for those fabrics where inconspicuous effects are desired. Blue, although not used to any great extent for fancy threads in men's-wear fabrics, is largely used for piece-dyed suitings. For ladies' dress goods, blue is a color that may be used in a variety of ways.

13. Green.—This color is of a retiring and inconspicuous nature, its principal characteristic being an appearance of freshness that is readily imparted to fabrics to which it is applied. Green is a very restful color to the eye, and is the most common color found in nature. According to the spectrum theory green is a primary color, but according to the pigment theory it is a secondary color, being

composed of the primary colors blue and yellow. For this reason green is an easier color with which to produce harmonious effects than the primary colors, since the more broken a color is the easier it usually is to make it combine with other colors with good effect. Many of the shades, tints, and hues of green are very useful in textile designing; among those most commonly used may be mentioned olive green, slate green, pea green, and dark green. The greens form excellent combinations with the shades and tints of red, when used in proper quantities, and also with black and white. Green is largely used for suitings, dress goods, shawls, broadcloths, billiard cloths, carriage cloths, etc., and is also employed as a fancy thread in men's wear, suitings, and trouserings.

14. Purple.—This color is not largely employed for textile fabrics at the present day, but in ancient times was the royal color and the most highly esteemed. The characteristics of purple are its richness of tone, bloom, and softness. This color finds a limited use in silk fabrics, furniture cloths, and draperies, but otherwise it is of very little importance at the present time.

15. Russet, Citrine, and Olive.—The tertiary colors, being still more broken, are more easily combined with harmonious results than either the primary or secondary colors, and, since they are quiet and subdued, they are the most useful colors in the ordinary run of designing, being especially adapted to men's wear.

16. It must be remembered that there are hundreds of shades, tints, and hues of either primary, secondary, or tertiary colors, and that the best combinations for quiet effects are obtained from such broken or modified colors. The pure, or full, colors rarely produce pleasing effects when used in combination.

FACTORS MODIFYING THE COLORING OF TEXTILE FABRICS

17. There are many factors that will modify the appearance of a color when applied to a fabric, but the principal ones may be said to be: (*a*) The nature of the raw material from which the fabric is constructed; (*b*) the structure of the yarn; (*c*) the build of the fabric; and (*d*) the finish of the cloth.

18. Dealing first with the **raw material,** it may be said that the difference in the structure of the fiber largely affects and, in fact, is the basis of the difference in the tones of color in textile fabrics of different materials.

With **wool** it is possible to obtain not only full, dull tones, but also bright and lustrous effects, depending on whether the yarn is woolen or worsted. With short wool fibers having a large number of serrations and being crimped and curled to a great extent, the resultant tones are deep, full, and somewhat dull. With the longer wool fibers, which have fewer serrations and, consequently, smoother surfaces, the reflecting power of the fiber is much greater and the colors obtained are therefore bright and lustrous.

Cotton is a fiber that is not so easily colored as wool, having less affinity for most dyestuffs. In general, the colors obtained on cotton are dull and have a flat, dead appearance, with the exception of mercerized cotton, which has a luster almost equal to silk.

Flax is a straight, compact, semitransparent fiber, on which colors appear bright and full, but not so lustrous as on silk or mercerized cotton.

Silk is a smooth, glass-like fiber on which color appears bright and true and with an incomparable luster.

19. The **structure of the yarn** is also an important factor in modifying the color effect of a fabric. A good example of this may be observed by comparing a woolen and a worsted yarn dyed in the same bath. The worsted yarn cannot fail to appear brighter in color than the woolen

yarn, because of the yarn structure. In the worsted yarn, the fibers are all laid parallel to the direction of the thread; thus, the sides of the fibers are exposed to the light, and, by reflection, heighten the lustrous effect and brighten the color. In the woolen yarn, the fibers are laid in all directions, and, projecting from the bulk of the thread, give it a fuzzy appearance. The effect of this is to partly absorb the light instead of reflecting it, thus giving the yarn a duller and deeper color.

The amount of twist in a thread also affects its color, slack-twisted yarns appearing brighter than hard-twisted yarns dyed the same color.

20. The effect of the **build of the fabric** in modifying the tone of the color is also apparent to an experienced designer. The more intersections of warp and filling there are in a fabric, the greater the tendency will be for the production of full but dull colors; and vice versa, the longer the floats of warp or filling, or both, the brighter the color and the more lustrous the fabric. That this is true may be readily seen by comparing a fabric woven with the plain weave and a similar cloth woven with a satin weave.

Another good illustration of how the build of a fabric affects the colors may be obtained by comparing a Brussels carpet, in which the pile is uncut, with a Wilton, or velvet, carpet, in which the pile is cut. In the latter the color always appears duller and more softly toned and possesses fulness and depth, while in the former the colors appear brighter and more pronounced, although the yarn may be dyed exactly the same. This is due, of course, to the one reflecting the light from the sides of the uncut pile, while the other, having the pile cut, absorbs the light to a great extent. That the colors are not dull in a cut-pile carpet may be readily seen by bending the pile over so that the light will fall on the sides of the pile instead of on the cut ends. Figured pile fabrics are sometimes made by utilizing this principle and combining cut and uncut pile according to the figure desired.

21. The character of the **finishing process** also has much to do with the appearance of the colors in a fabric,

and they may be made to appear bright and lustrous or dull and full according to the finish and the nature of the fabric. Many woolen fabrics are steamed, which, combined with the brushing and other processes through which they go, gives them great luster. Those fabrics that are sheared and singed close show the colors bright and true, while those having a short, thick nap show duller and fuller tones of color. Cloths with long and sparsely raised naps that are brushed and laid flat are very lustrous.

METHODS OF APPLYING COLOR TO TEXTILES

22. Color is applied to textiles in several ways, the method of application and the character of the design depending largely on the class of fabric desired and whether it is to be made of cotton, woolen, worsted, or silk yarns. Piece-dyed fabrics are woven white and then dyed a solid color; or a fabric all one color may be made by dyeing either the raw stock or the yarn. Mixture yarns and fabrics are made in woolen and other goods by mixing raw materials of different colors. In woven fancy patterns, the fabric is colored and the pattern formed in the majority of cases by the use of colored yarns in the warp or filling, or in both warp and filling, in combination with a definite method of interlacing the warp and filling. Printed goods are those to which the color is applied by a stamping or printing process. Usually the pattern is engraved on a series of copper rolls that are afterwards placed in a machine that prints the desired colors on the cloth.

COLOR EFFECTS

23. Definition.—Distinction is made between a *weave effect* and a *color effect.* The effect produced by the interlacing of warp and filling, when both are of the same color, or the warp one color and the filling another, is said to be a **weave effect.** If, on the other hand, either the warp or the filling, or both, consists of an arrangement, or pattern, of colored yarns, the effect produced by their interlacing is

termed a **color effect.** It may therefore be stated that a weave effect is the effect of the interlacing of the warp and filling alone, whereas a color effect is the effect of colored yarns combined with a suitable weave.

In a color effect, the weave is lost and is hardly noticeable in the pattern or design. This is, of course, due to the weave effect being broken up by the colors used in the composition of the pattern. Color effects are often—in fact, generally—produced with very simple weaves and with warp and filling patterns with few ends and picks in a repeat. Figures and effects may thus be produced that, although small, may be combined with other small but different figures or effects to produce large and effective stripes and checks.

24. Method of Making Color Effects.—It often happens that the designer, when making a design, desires to ascertain what the exact effect of a certain weave together with certain warp and filling patterns will be when the cloth is woven in the loom. When this is the case he proceeds to make a sketch of the effect, using colored pencils, paints, or inks as nearly like the colors to be used in the cloth as possible, or if he only desires to know the form of the pattern or the size of the spot or figure to be produced, he may simply sketch it out in pencil or ink and make a black-and-white effect, provided that not more than two colors are used in either warp or filling. If three colors are used, one color must be indicated in some other manner.

In making a color effect, the first process is to dot the weave very lightly on design paper. Instead of dotting the weave, a very convenient method is to prick it on the design paper with a dissecting needle or other sharp instrument. The manner of arranging the colors of the warp may then be indicated for convenience on a horizontal line of squares above or below the weave. Then mark with the proper color each warp end where it covers the filling. The filling pattern may then be arranged in the same manner and each pick of filling marked with its proper color wherever it floats over the warp.

To illustrate this process, suppose that Fig. 2 represents a weave that is to be warped and picked 1 of black and 1 of white, as indicated by the horizontal and vertical rows of squares at the sides in which the coloring of the pattern is represented. It will be noticed that this weave is a check design on 24 ends and 24 picks, formed by cutting the cassimere twill. The effect of this weave when warped and picked as indicated is found, according to the method previously explained, as follows: The black warp ends are first marked with black wherever they float on the face of the cloth; this is shown in Fig. 3. It is not necessary to mark the white warp ends, as they will be white wherever they are on the surface, and in this connection it should be noted that, wherever a warp end is white in a color effect, it will be necessary to erase the dots indicating the weave or the interlacing of that end with the filling before the color effect is finished. The next step is to mark the picks of filling, wherever they pass over

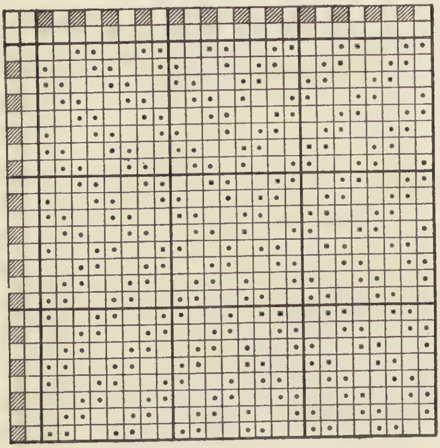

Fig. 2

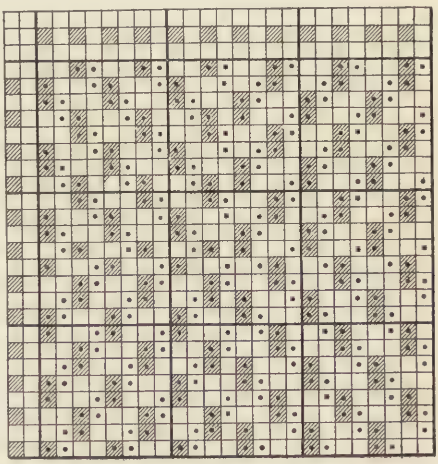

Fig. 3

the warp ends, with the proper color, as indicated by the scheme of filling, or filling pattern. This being accomplished, the color effect as shown in Fig. 4 is obtained, but, as some of the warp ends are white and show the dots that indicate their interlacings with the filling, it will be necessary to erase these, after which the completed color effect, as shown in Fig. 5, will be obtained. The same method of making a color effect is employed whether only two colors are used or several, and whatever may be the warp and filling patterns.

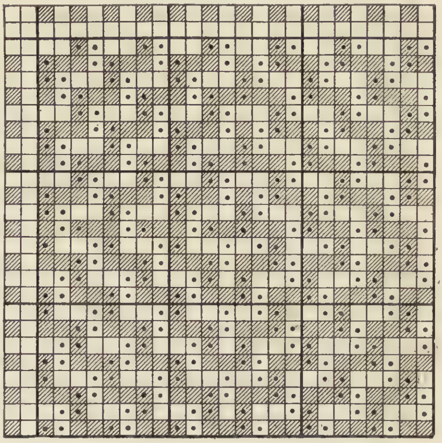

FIG. 4

25. Repeats.—A color effect may require a greater number of ends and picks to show one repeat than either the weave or the warp and filling patterns require. If the patterns of warp and filling do not require more ends and picks than the weave, and if the number of ends and picks required for the patterns are exactly divisible into the number of ends and picks required for the weave, the color effect will be complete on the same number of ends and picks as the weave. The number

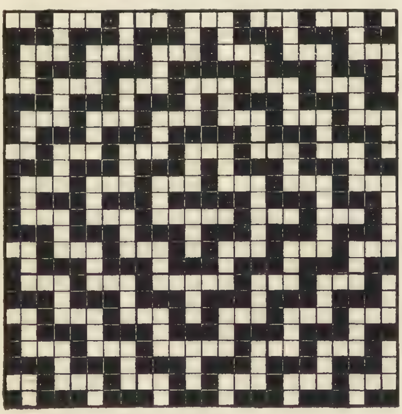

FIG. 5

of ends required to show one repeat of a color effect is equal to the least common multiple of the ends required for the weave and the ends in the warp pattern. Similarly, the number of picks required is the least common multiple of the picks in one repeat of the filling pattern and the picks in one repeat of the weave. For instance, if a cloth is to be woven with a weave complete on 8 ends and 6 picks and the pattern of the warp contains 10 ends while the filling pattern requires 7 picks, then 40 ends and 42 picks will be required to show one repeat of the color effect because 40 is the least common multiple of 8 and 10, while 42 is the least common multiple of 6 and 7; that is, in every case the pattern of the warp and the pattern of the filling must repeat with the weave before one repeat of the color effect is obtained.

26. Importance of Records.—It is of the utmost importance that the designer shall keep detailed records of the color schemes of all the fabrics manufactured by the mill, since if there is a slight change in the order of the coloring, or if the colors are not inserted in the cloth on the proper pick of the weave, the entire color effect may be changed. The importance of this may be seen by making two color effects with the plain weave, both to be arranged 1 black and 1 white in the warp, one effect to be arranged 1 white and 1 black in the filling and the other, 1 black and 1 white. One of these color effects will be a fine hair-line stripe running in the direction of the warp, while the other will be a similar stripe but running across the cloth.

Although this may seem to be an exceptional case, it may be stated that, in almost every instance, a radical change is made in a color effect by inserting the colors on the wrong picks.

EXAMPLES FOR PRACTICE

1. Show the effects produced by warping and picking the plain weave as explained in Art. **26**.

2. Show the color effect on 16 ends and 16 picks obtained by warping and picking the plain weave 2 black and 2 white.

3. Show the effect on 12 ends and 12 picks of coloring the cassimere twill 1 black and 1 white in both warp and filling.

4. Show the effect on 16 ends and 16 picks of coloring the 8-end twill (Weave 184, *Glossary of Weaves*), 1 white, 1 black, 1 green, and 1 red in both warp and filling.

5. Show the effect of a 3 and 3 coloring in both warp and filling with the 8-harness twilled basket (Weave 189, *Glossary of Weaves*).

ANALYZING COLOR EFFECTS

27. It sometimes becomes necessary for the designer not only to make a color effect, but to analyze one in order to find the warp and filling patterns and the weave. If these items are to be obtained from a sample of cloth, no difficulty will be experienced, since in this case the fabric may be dissected and the warp and filling patterns indicated on the pick-out as the analysis proceeds. If, however, it is desired to find the weave and the warp and filling patterns of a color effect that is represented on design paper in a conventional manner, greater difficulty will be met with since in this case there is no method of directly ascertaining the weave or whether any given portion of the color effect is due to warp or filling yarns. There is no method of accurately analyzing a color effect other than that based on the judgment of the designer who, after becoming acquainted with the effects produced by certain orders of coloring and certain weaves, is often able to analyze the color effect off-hand, as it were. It is not meant by this that it is impossible to find a weave and orders of coloring that will give a certain color effect, but that there is no method of knowing whether this was the original scheme or not, since different weaves combined with different orders of coloring may give the same color effect. For instance, if the plain weave $\frac{1}{1}$ is arranged in the warp 1 black, 1 white, 1 black, 1 white, and in the filling, 1 white, 1 black, 1 white, 1 black, a color effect known as a hair-line stripe will be produced, and if the crow twill $\frac{3}{1}$ is arranged 1 black, 1 white, 1 black, 1 white in both warp and filling, exactly the same color effect is produced. In analyzing a color effect, therefore, although neither the original scheme

of warp and filling nor the original weave may be obtained, yet the results will be correct. Care should be taken in this connection, however, to obtain as simple warp and filling patterns and as regular a weave as possible, since this is always an advantage and in all probability will be more apt to be the original scheme.

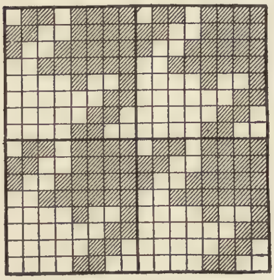

FIG. 6

In order to explain the method employed in analyzing a color effect, an example will be taken, and it will be supposed that Fig. 6 represents a color effect that it is desired to know how to produce. The first operation in analyzing a color effect is to decide on the warp and filling pattern.

As a general rule, the order of arranging the colors in the warp and filling may be recognized by certain ends and picks having a preponderance of a certain color on the surface. Thus, in Fig. 6, it will be noticed that the first, second, third, fourth, ninth, tenth, eleventh, and twelfth ends are mostly white, each having only 4 black risers, while the fifth, sixth, seventh, eighth, thirteenth, fourteenth, fifteenth, and sixteenth ends are nearly all black, only 4 risers being white. From this it would be judged that the warp in this color effect was arranged 4 white, 4 black, 4 white, 4 black. By the same method it would be judged that the filling pattern was also arranged in the same order, since the first 4 picks appear to be white and the next 4, black, etc. Having decided on the warp and filling patterns, they should be indicated along two sides of the design as shown in Fig. 7.

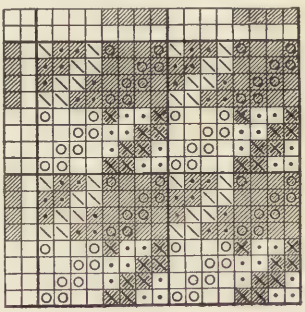

FIG. 7

28. The next operation is to mark where the black warp ends cover the white picks; this is shown in Fig. 7 by the

crosses. As the color effect is black at this point, it is evident that the warp must be raised here, since if the filling were raised at this point, the effect would be white.

The next operation is to mark all the places where the white warp is raised over the black picks; this is shown by the oblique marks on Fig. 7. Before going further with the analysis it is best for the beginner, in all cases, and for the more experienced designer, on complicated effects, to place distinguishing marks on those parts of the design where the warp must be depressed; that is, in this case where white filling must cover black warp and where black filling must cover white warp. These distinguishing marks are not a part of the weave, since they represent filling up, but are here used simply to prevent confusion. They are represented in Fig. 7 by the small dots.

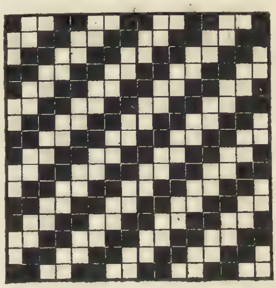

Fig. 8

It is evident that the weave as now obtained would produce the required color effect (not considering, of course, the dots as part of the weave), since, in those parts of the design that have not been marked, color covers color; that is, the warp and filling are of the same color. However, the cloth would not be firmly nor regularly built with such a weave, and so it is necessary to make a more regular weave.

Since, in all those parts of the design not marked, color covers color, it makes no difference whether warp or filling is on the surface so far as the color effect is concerned, and so the warp may be raised or lowered at these points in the manner best suited for producing a regular weave. By adding risers to this design, as shown by the small circles in Fig. 7, we produce the most regular weave possible in this case, being simply the 4-harness twill as shown in Fig. 8. This figure is obtained by copying all of the marks in Fig. 7 with the exception of the dots, which, as previously explained, mean that the filling is up, and of course have no place in the weave.

In order to make the method of analyzing a color effect clearer, another example will be given, of a slightly more

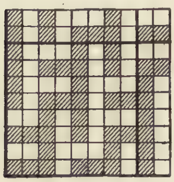

FIG. 9

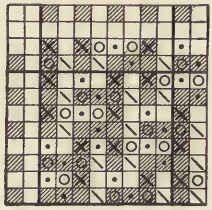

FIG. 10

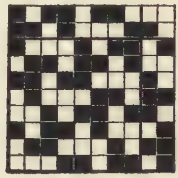

FIG. 11

complicated nature, although the method employed in its analysis is the same. Suppose that it is desired to analyze

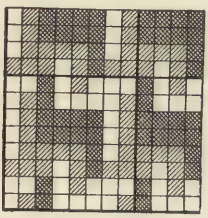

FIG. 12

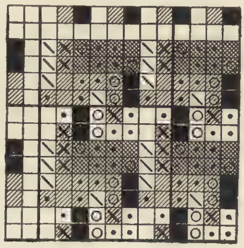

FIG. 13

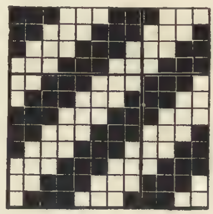

FIG. 14

the effect shown in Fig. 9. Carefully studying this, as in the previous example, it will be seen that it is warped and picked

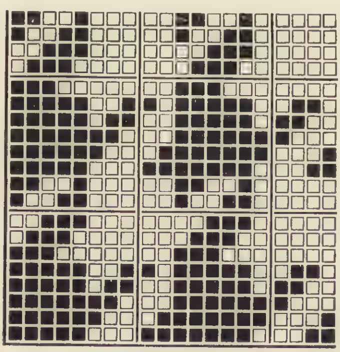

FIG. 15

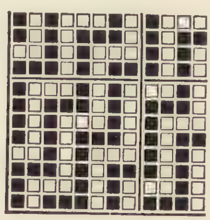

FIG. 16

1 and 1. Then proceeding with the analysis, the crosses in Fig. 10 show where the black warp is raised over the white

filling; the oblique marks, where the white warp is raised over the black filling; the dots show where the filling must float over the warp and do not enter into the weave; and the small circles show the risers that have been added to make a regular weave. Fig. 11 shows the weave obtained by copying all the marks except the dots.

When a color effect contains more than two colors, the same method of analysis is followed out, except that three or more colors must be considered instead of two. For instance, suppose that it is desired to analyze the color effect shown at Fig. 12, which is composed of three colors—white,

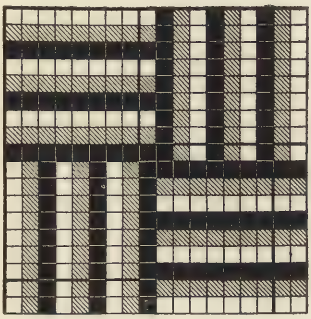

Fig. 17

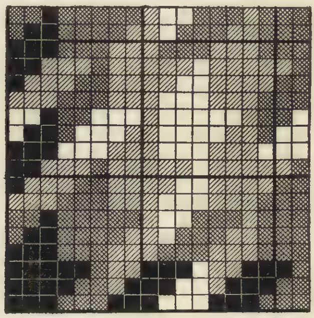

Fig. 18

gray, and black. Carefully studying this color effect, it will be seen that the warp pattern is arranged 1 white, 1 gray, and 1 black and the filling pattern 2 white, 2 gray, and 2 black. Proceeding with the analysis, the oblique marks in Fig. 13 show where the white warp must be raised over the gray and black picks; the crosses show where the gray warp must be raised over the white and black filling; and the filled squares where the black warp must be raised. The dots show where the color effect calls for filling up, while the small circles are the risers added for the purpose of marking a regular weave. Fig. 14 is the weave used, and is obtained by copying all the marks placed on Fig. 13, except the dots.

EXAMPLES FOR PRACTICE

1. Analyze the color effect shown in Fig. 15.

2. Give weave and order of coloring for producing the color effect in Fig. 16.

3. Analyze the effect in three colors shown in Fig. 17, giving the weave and the warp and filling patterns.

4. Analyze the effect in four colors shown in Fig. 18.

COLOR IN TEXTILE DESIGNING

(PART 2)

SIMPLE AND COMPOUND COLORINGS

INTRODUCTION

1. Definitions.—There are certain well-known orders of coloring that, when applied to simple weaves, produce what might be termed *standard effects*. These orders of coloring may be divided into two classes; namely, *simple* and *compound colorings*, each of which may in turn be divided into *regular* and *irregular* arrangements.

Generally speaking, a **simple** order of coloring may be said to be one in which the colors are arranged on a regular and comparatively simple system, while a **compound** order may be considered as an arrangement obtained by uniting two or more simple arrangements. For instance, if the yarns in a certain piece of cloth are arranged 4 white, 4 blue, 4 red, 4 black, the order of coloring is said to be simple. If, however, the yarns are arranged

$$\left.\begin{matrix}\text{4 white}\\\text{4 blue}\end{matrix}\right\}\text{for 24 threads}$$

$$\left.\begin{matrix}\text{4 red}\\\text{4 black}\end{matrix}\right\}\text{for 24 threads}$$

the order of coloring is said to be compound, since it is really the result of combining two 4 and 4 simple colorings.

2. Regular and Irregular Simple Colorings.—A **regular simple coloring** is one in which the amount of each color is the same and the order of their arrangement is regular. Thus, if a cloth is colored 2 red, 2 white, 2 black, the order of coloring is regular and simple. **Irregular simple colorings** are those in which the regular structure is somewhat broken up, but which are still simple colorings as opposed to compound colorings.

There are three ways of forming irregular simple arrangements: (1) By rearranging the order of the colors in a regular simple pattern; (2) by varying the amount of each color; (3) by combining the first two methods.

As an illustration of the first method, suppose that the regular simple coloring given above were arranged 2 red, 2 black, 2 white, 2 black, then it would be changed to an irregular simple coloring. If the pattern were arranged 6 red, 4 white, 2 black, it would be changed into an irregular coloring by the second method; while if arranged 8 red, 6 black, 4 white, 2 black, or in some similar manner, it would be made irregular by the third method. It will be understood that in the pattern obtained by the first method the amount of black yarn is doubled, although the amount of color in any one part of the pattern remains the same.

REGULAR SIMPLE COLORINGS

TWO-COLOR PATTERNS

3. The most elementary **regular simple colorings** are the **two-color effects**, which are generally arranged on the *one and one*, *two and two*, *three and three*, or *four and four* system.

4. One and One Colorings.—If the plain weave, with the first warp end raised over the first pick, is warped and picked 1 white and 1 black, a hair line running across the cloth is formed; if warped 1 white and 1 black and picked 1 black and 1 white, a hair-line stripe running in the direction of the warp is formed. Reversing the weave will also have the effect of reversing the direction of the stripe. If

the plain weave is warped 1 white and 1 black and picked with black filling, an effect is formed consisting of small white spots distributed on a black ground, and if woven with white filling, a black spot is formed on a white ground.

5. Figured Effects With the Plain Weave.—Use is sometimes made of the hair-line effects produced with the plain weave for forming figures. This is accomplished by reversing the plain weave in certain portions of the design where the figure is desired, and warping and picking the

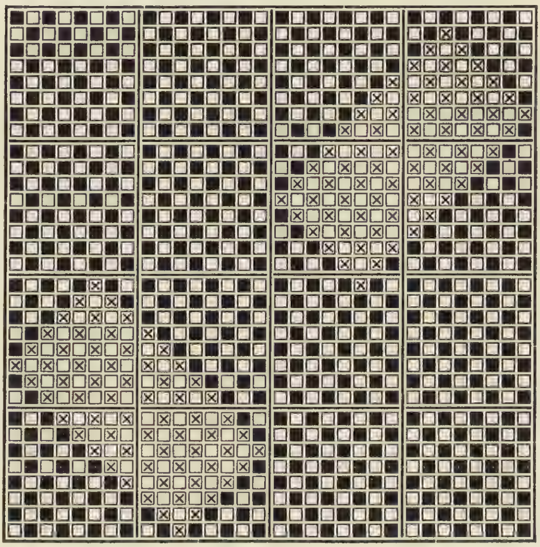

Fig. 1

cloth on the one and one system. The effect of this is to make a figure of fine lines of color running in one direction on a ground consisting of fine lines running at right angles. Fig. 1 shows a weave made on this principle, and Fig. 2 shows the effect produced by warping and picking 1 white and 1 black.

6. Two-Color Step Effects.—One and one colorings in both warp and filling produce with the cassimere twill what are known as **step effects.** Fig. 3 shows a two-color step

effect obtained by warping and picking this twill 1 white and 1 black. This step effect can be made to twill in the opposite direction by reversing the twill of the weave so that it will run to the left. Fig. 4 shows another step effect of a slightly

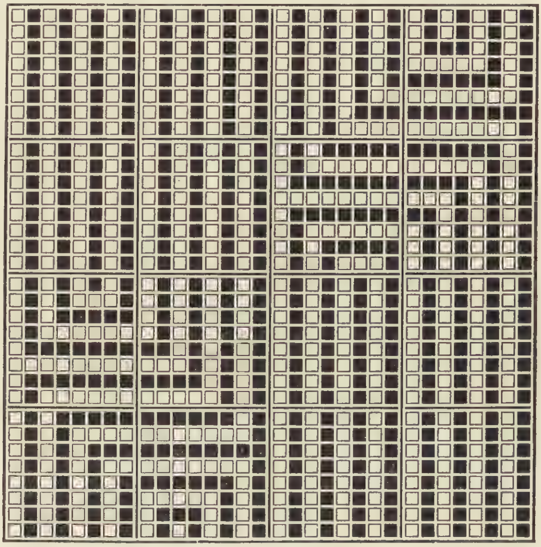

FIG. 2

different character, obtained by warping and picking the $\frac{3}{3}$ twill 1 white and 1 black. An upright step effect obtained with this same weave is shown in Fig. 5. This is produced by

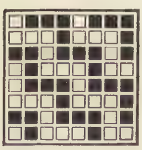

FIG. 3

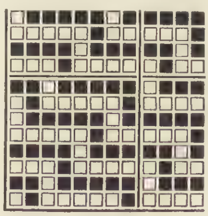

FIG. 4

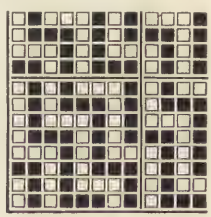

FIG. 5

warping 1 white and 1 black and picking 1 black and 1 white. Two-color step effects twilling at an even steeper angle than Fig. 5, or a flatter angle than Fig. 4, may be obtained by using a one and one warping and picking with the $\frac{4}{4}$ twill.

7. Figured Step Effects.—Quite novel effects may be obtained with the cassimere and other twills, together with a one and one warping and picking, by altering the positions of the weaves in the same manner as was done when making the figured design with the plain weave. Fig. 6 shows a weave arranged for a design on this principle, the shaded part indicating where the weave has been reversed according to a motive. Fig. 7 shows the effect produced by warping and picking 1 white and 1 black. In designs like

FIG. 6

Fig. 6, if the figure is made larger it will be more pronounced, but even small figures give a unique pattern of a somewhat all-over effect, as is shown in Fig. 7.

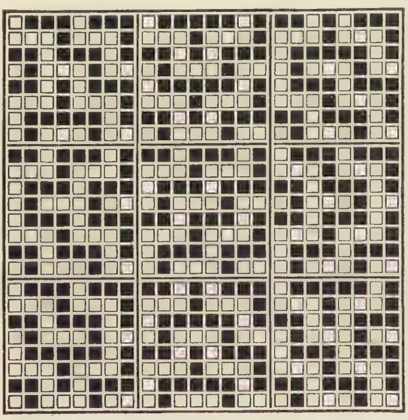

FIG. 7

In Fig. 8, another rather unique color effect is shown. This is obtained by warping and picking a cut check design on 24 ends and 24 picks made with the $\frac{3}{3}$ twill, 1 white and 1 black. The effect shown in Fig. 8 is an especially good one for a cloth containing more ends than picks per inch, on account of the long floats of color running in the direction of the filling. An excellent effect can be produced by this method with the cassimere instead of the $\frac{3}{3}$ twill. If,

instead of making a check design with the cassimere, a cut stripe weave is formed, a very unique stripe, or wave, effect is produced by warping and picking on the one and one system. Fig. 9 shows a stripe weave made with the cassimere twill, and Fig. 10 shows the effect of warping and picking 1 white and 1 black. By reversing and cutting the cassimere twill warp-way instead of filling-way the wave effect will be produced lengthwise of the cloth instead of across the fabric.

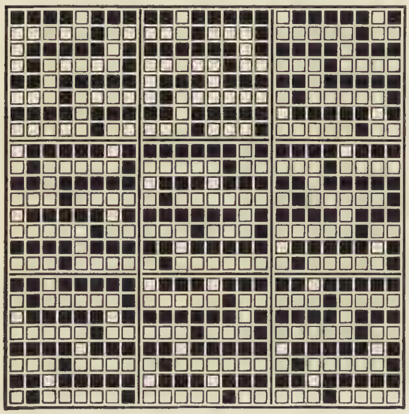

FIG. 8

8. Two and Two Colorings.—Many good effects may be obtained with two and two colorings in connection with simple weaves and with weave combinations. In Fig. 11, the effect produced with the plain weave by warping and picking 2 white and 2 black is shown. This produces a small check effect used in worsted suitings and dress goods

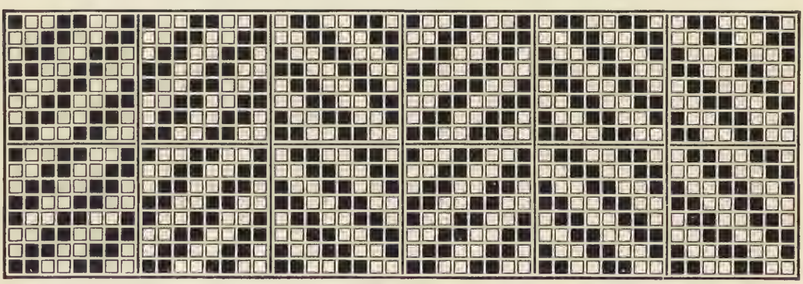

FIG. 9

to some extent. A variety of effects may be obtained with any one weave by using a two and two warping together with solid filling or with two and two picking. For instance, Fig. 12 shows the effect produced by warping the cassimere

twill 2 white and 2 black and using white filling; Fig. 13 shows the effect obtained by using black filling; and Fig. 14, the effect obtained by picking 2 black and 2 white. In Fig. 12, a broken black stripe is formed on a white ground; while in Fig. 13, a broken white stripe on a black

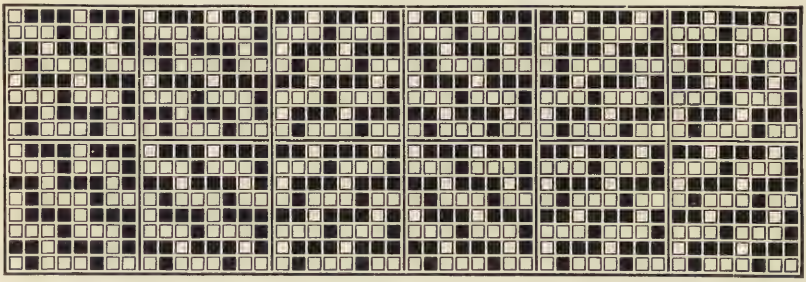

FIG. 10

ground is produced. In Fig. 14, continuous black and white stripes running lengthwise of the piece are formed, but if the cassimere weave were picked as warped, the effect would run crosswise of the goods.

With the 4-end basket weave, a continuous stripe similar to the hair line, but containing two ends of each color, may

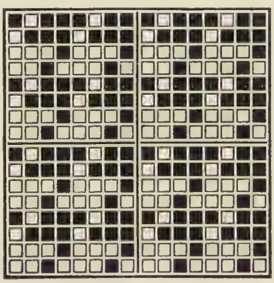

FIG. 11

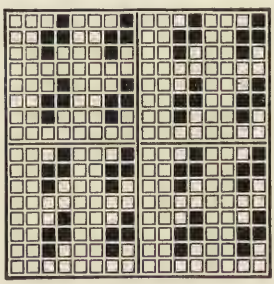

FIG. 12

be obtained by warping 2 white and 2 black, and arranging the filling on the two and two principle in such a manner that color will cover color; that is, so that black filling will cover black warp where the latter is depressed and white filling will cover white warp in the same manner. For instance, by warping 2 white and 2 black and picking 2 black

and 2 white the stripes will run lengthwise, if the first two ends of the weave are raised over the first two picks.

9. Three and Three Colorings.—The three and three system of coloring yields with the 6-end twill $\frac{3}{3}$, to which it is well adapted, effects somewhat analogous to those

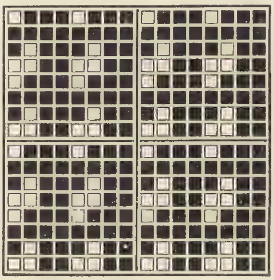

Fig. 13

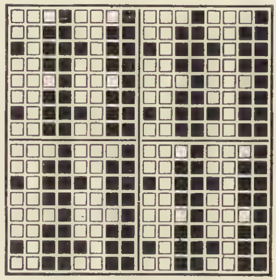

Fig. 14

obtained with a two and two coloring and the cassimere twill. Fig. 15 shows the effect of a 3 white and 3 black warp arrangement and a black filling with the 6-end twill. In this case, a broken white stripe on a black ground is formed, but if white filling were used, the effect would be

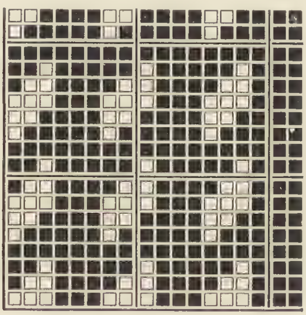

Fig. 15

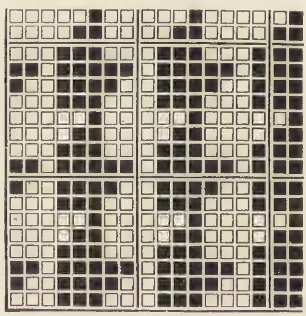

Fig. 16

reversed. Fig. 16 shows the effect of warping the 6-end twill 3 white and 3 black and picking 3 black and 3 white. It will be noticed that the spots are connected, in this figure, to form stripes lengthwise of the piece, while if the weave were picked 3 white and 3 black, the same general effect would be obtained, but they would be connected in the

direction of the width of the fabric. Quite an effective stripe is shown in Fig. 17, being obtained by coloring the warp prunelle twill 3 white and 3 black in both warp and filling.

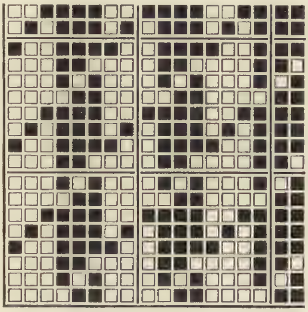

Fig. 17

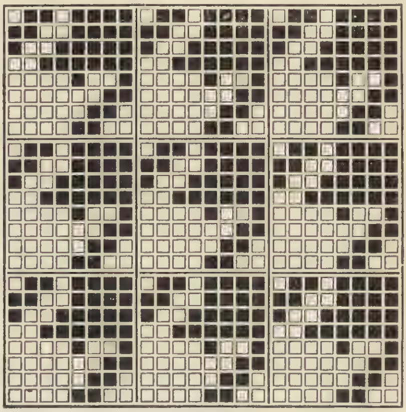

Fig. 18

10. Four and Four Colorings.—Four and four colorings produce good color effects both with the cassimere and with the 8-end $\frac{4}{4}$ twill. In Fig. 18, a very common effect in woolen suitings known as the *shepherd's check* is shown. This is made by warping and picking the cassimere twill 4 white and 4 black. Fig. 19 shows the effect obtained by warping the $\frac{4}{4}$ regular twill 4 white and 4 black and picking 4 black and 4 white. The effects in either Fig. 18 or Fig. 19 may be connected filling-way instead of warp-way by simply altering the picking plan. Broken stripes may be made with either the cassimere or the $\frac{4}{4}$ twill by warping on the four and four system and picking with solid color filling.

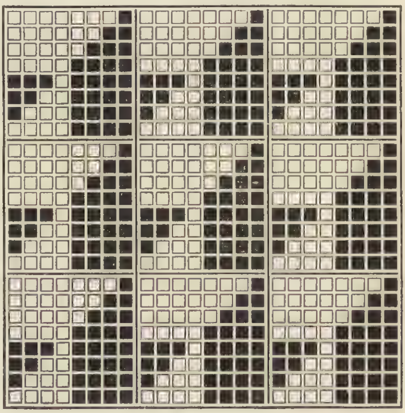

Fig. 19

A good effect for a dress-goods pattern is shown in Fig. 20. This is obtained by coloring the 10-end weave shown in Fig. 21, 4 black and 4 white in both warp and filling. As the

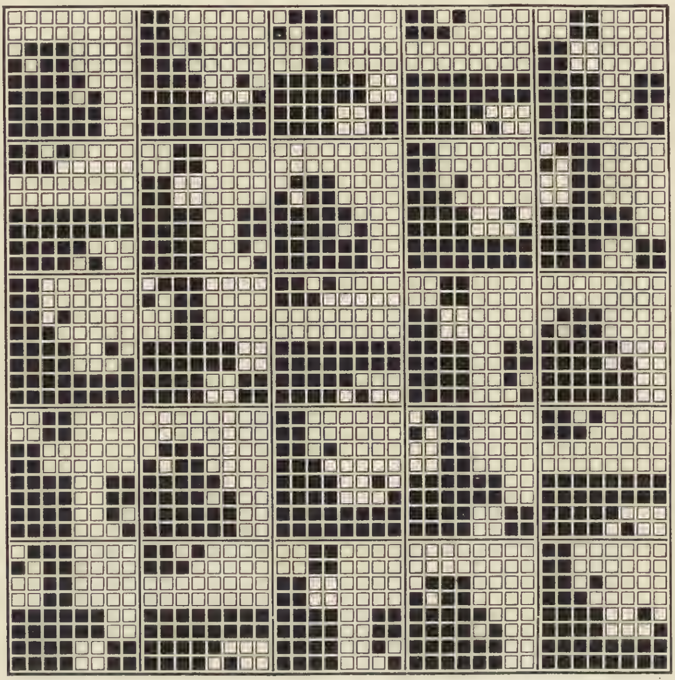

FIG. 20

coloring is complete on 8 ends and 8 picks, and the weave requires 10 ends and 10 picks, it is evident that 40 ends and 40 picks will be required to show one repeat of the color effect, since 40 is the least common multiple of 8 and 10.

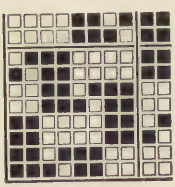

FIG. 21

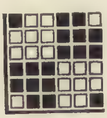

FIG. 22

11. Extensions of Regular Two-Color Patterns. The principle of coloring discussed is often extended to six and six, and eight and eight, and as high as, or even higher than, sixteen and sixteen colorings. These may be employed to advantage with

simple weaves and also with check weaves made by combining twills, twill and basket, or twill and plain weaves, etc. It will be understood that the effects given are only a few of the desirable patterns that may be obtained, since small fancy weaves

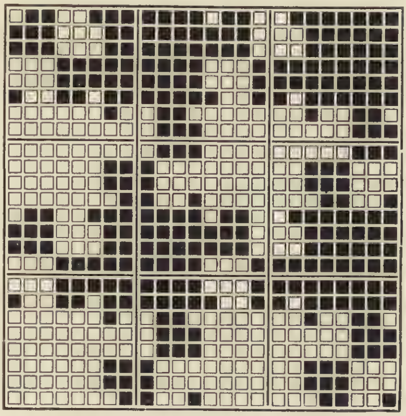

FIG. 23

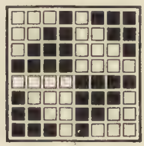

FIG. 24

and ingenious groupings of weaves and colorings will often produce excellent effects. The limit of patterns that may

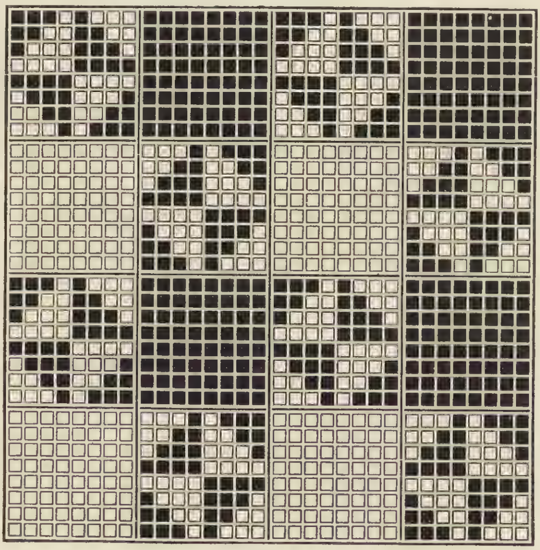

FIG. 25

be obtained may be said to exist only in the limit of the

designer's ingenuity. A few examples will suffice to illustrate the patterns that may be obtained by the extension of the principle of two-shade regular colorings.

In Fig. 22, a small basket weave is illustrated, while Fig. 23 shows the effect of warping and picking this weave 6 white and 6 black. This is a very neat effect, suitable for worsted or woolen dress goods or suitings. An effect obtained in a somewhat similar manner with the weave shown in Fig. 24 and an eight and eight coloring in both warp and filling is shown in Fig. 25.

EXAMPLES FOR PRACTICE

1. Make an original one and one two-color figured effect with the plain weave.

2. (*a*) Make a two-color step effect with the 10-harness regular twill $\frac{5}{5}$. (*b*) Change the picking plan so as to alter the angle at which the effect is twilled.

3. Make a cut check weave on 32 ends and 32 picks with the cassimere twill and show the effect by warping and picking on the one and one two-color system.

4. Show the effect of a two and two coloring with the 4-end regular basket weave.

5. Show the effect of a three and three two-color warping and picking with the cassimere twill.

6. Make an original color effect on the principle of Fig. 23.

THREE-COLOR PATTERNS

12. In **three-color** regular colorings, the same methods are followed as with two-color patterns except that three colors are used. For instance, a one and one coloring consists of 3 ends or 3 picks, each of a different color and arranged in regular order in the cloth. A two and two coloring is the same thing, only there are 2 ends of each color together, etc.

13. One and One Colorings.—In one and one colorings on this system, there are several desirable effects that may be produced. With the warp prunelle weave, a three-color

hair-line stripe may be produced by arranging the warp 1 white, 1 gray, 1 black, or any other suitable colors, and so arranging the filling with the same colors that each pick of

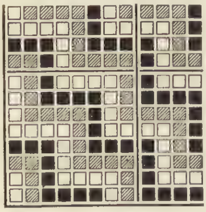

Fig. 26

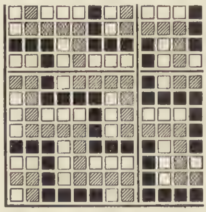

Fig. 27

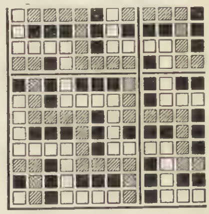

Fig. 28

filling will cover its own color of warp when the latter is depressed.

In Fig. 26, a three-color step effect is shown. This is made by warping the 6-end twill $\frac{3}{3}$ 1 white, 1 gray, 1 black

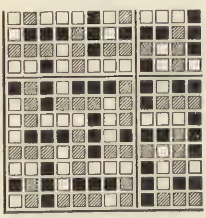

Fig. 29

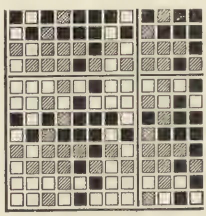

Fig. 30

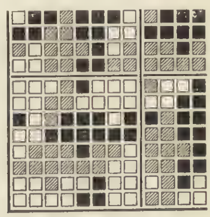

Fig. 31

and arranging the filling 1 black, 1 white, 1 gray. Figs. 27 to 29, inclusive, show three useful modifications of the step effect obtained with the same weave and warp arrangement

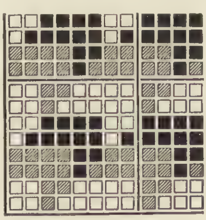

Fig. 32

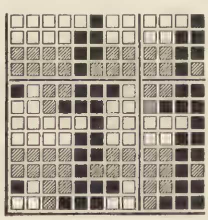

Fig. 33

by altering the arrangement of the filling. In Fig. 27, the white effect is broken up and the black and gray colors only form continuous step effects. This is obtained by

picking 1 black, 1 gray, 1 white. In Fig. 28, the black effect is broken and the gray and white are continuous; this is obtained by picking 1 white, 1 black, 1 gray. By picking 1 gray, 1 black, 1 white, as in Fig. 29, the step effect is entirely destroyed, each of the three colors being broken up.

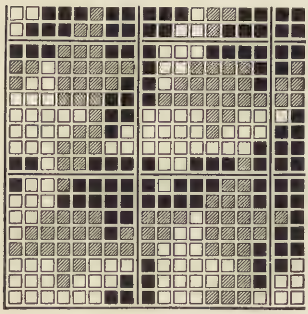

Fig. 34

14. Two and Two Colorings.—Many desirable patterns are produced by this method of coloring. In Fig. 30, the effect is shown of warping and picking the plain weave 2 white, 2 gray, 2 black. In Fig. 31, a very neat effect is shown, obtained by warping and picking

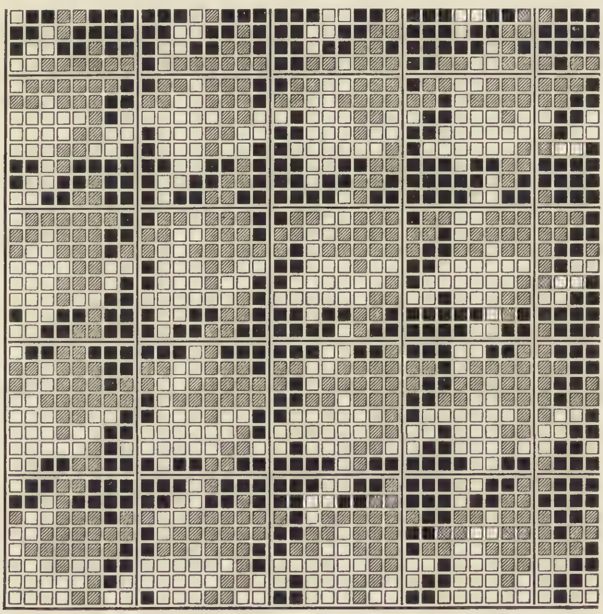

Fig. 35

the cassimere twill 2 white, 2 gray, 2 black. Fig. 32 shows the effect obtained by using the same arrangement of colors

and the 6-harness regular twill. Fig. 33 shows another very useful effect obtained with the same weave and arrangement of colors in the warp as shown in Fig. 32. The color in the filling of this effect is arranged, however, 2 black, 2 gray, 2 white.

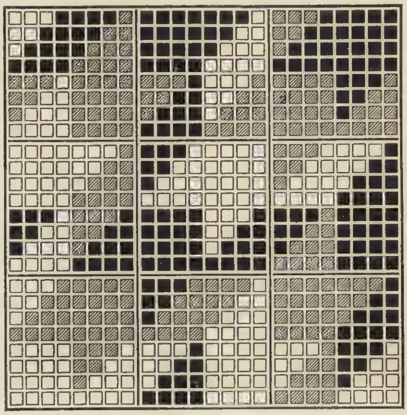

Fig. 36

15. Three and Three Colorings. Like other simple colorings, this arrangement is one that, if used with suitable colors, is capable of producing very neat and useful effects. Fig. 34 shows a neat check effect obtained by warping and picking the 6-end regular twill $\frac{3}{3}$ 3 white, 3 gray, 3 black. Fig. 35 shows a somewhat broken check effect obtained with the same warping and picking as Fig. 34, but made with the cassimere twill. Since, in this effect, the weave requires 4 ends and 4 picks, while the warp and filling patterns require 9 ends and 9 picks, 36 ends and 36 picks are required for one repeat of the color effect, as this number is the least common multiple of 4 and 9. This is a very suitable effect for fine worsted suitings if the colors used harmonize well.

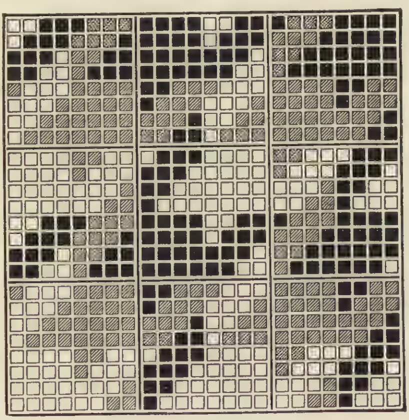

Fig. 37

16. Four and Four Colorings.—Effects obtained on this principle are somewhat bolder, since the color is applied in larger amounts, but the effects produced may be adapted

to almost any fabric by using suitable colors. Three effects of this method of coloring are shown in Figs. 36, 37, and 38, in all of which the order of coloring in both warp and filling is 4 white, 4 gray, 4 black. Fig. 36 is based on the 8-end regular twill $\frac{4}{4}$; Fig. 37, on the 6-end twill $\frac{3}{3}$; and Fig. 38, on the cassimere twill. Many other effects may be made with this order of coloring by using different weaves or weave combinations. As in two-color patterns, the four and four order of coloring is often extended to six and six, eight and eight, etc.

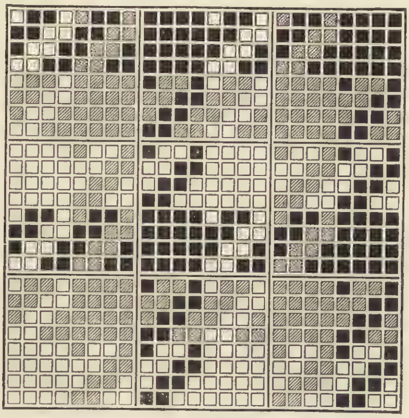
FIG. 38

FOUR-COLOR PATTERNS

17. A greater variety of patterns may be obtained with four colors than with either two or three, and, generally speaking, the effects obtained are more broken and the patterns more diversified in form and grouping. The same methods of grouping the colors are employed with four-color regular simple colorings as with the two- and three-color patterns.

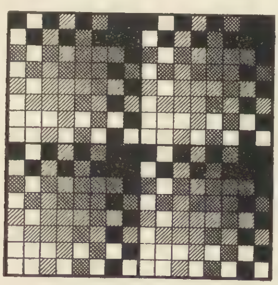
FIG. 39

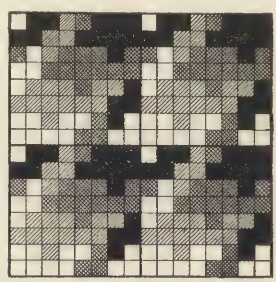
FIG. 40

18. One and One Colorings.—In one and one colorings in this system, there are several desirable effects that may be obtained. With the warp-flush crow twill, a four-color hair-line stripe may be produced by arranging the warp, 1 white, 1 light gray, 1 dark gray, 1 black, (or any other suitable colors), and so arranging the filling that each color will cover its own color warp when the latter is depressed. Step effects may also be made on this principle after the style of Figs. 26, 27, 28, and 29, by using the $\frac{4}{4}$ regular twill.

19. Two and Two Colorings.—The effect obtained by coloring the plain weave 2 white, 2 light gray, 2 dark gray, 2 black, in both warp and filling, is shown in Fig. 39, while in Fig. 40 the effect is shown of the same coloring on the cassimere twill. Good effects may also be obtained on this system by the use of other weaves and by using any four harmonious colors.

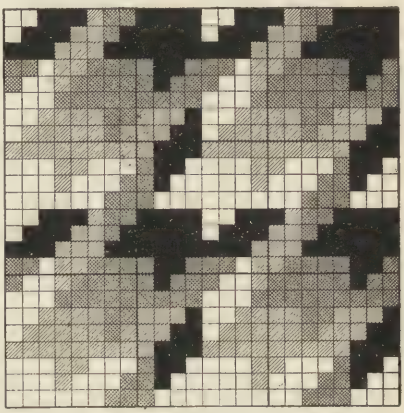

FIG. 41

20. Three and Three Colorings. Colors arranged on this system are adapted to the cassimere and 6-harness twills, and to small, neat, fancy weaves with which they give good results. Fig. 41 shows the effect of warping and picking the 6-harness twill 3 white, 3 light gray, 3 dark gray, 3 black.

21. Four and Four Colorings.—Like those previously described, this system of applying color may be employed with a variety of weaves or weave combinations and with any colors suitable for the fabric being made. In Fig. 42, the effect is shown of warping and picking the cassimere twill 4 white, 4 light gray, 4 dark gray, 4 black. In most cases, the size and diversity of the patterns produced by

regular simple colorings are greatly increased by using weaves that are not exactly divisible into, or by, the pattern used.

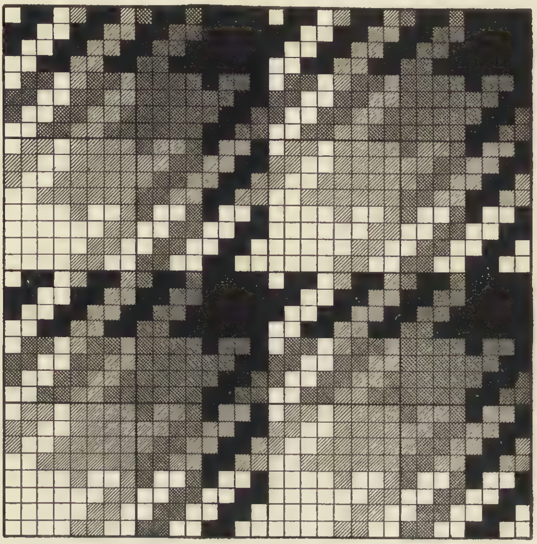

Fig. 42

EXAMPLES FOR PRACTICE

1. Make a broken three-color step effect similar to Figs. 27 and 28, but having only the gray effect broken, the black and white forming continuous steps.

2. Show an original color effect on the two and two three-color system.

3. Show the effect produced by a three and three three-color arrangement with the 4-end basket weave.

4. Make an original two and two four-color effect.

5. Show the effect produced by a three and three four-color arrangement with the 8-harness twilled basket weave.

IRREGULAR SIMPLE COLORINGS

22. There is a large variety of **irregular simple colorings,** and, in general, it may be said that they are usually adopted in connection with specific weaves to form certain effects. The number of standard irregular simple colorings, however, is small; in fact, this system of coloring is less sharply defined than that of regular simple colorings, and in some cases the arrangement of color may almost be mistaken for a compound coloring.

IRREGULAR TWO-COLOR SIMPLE PATTERNS

23. There are a large number of effects that may be obtained with two colors and irregular simple arrangements. For instance, Fig. 43 shows a stripe design obtained with the warp prunelle twill by warping 2 black and 1 white and picking 1 white and 2 black. By using the filling-flush prunelle and arranging the filling the same as the warp, the effect may be made to run across instead of lengthwise of the cloth. Similar stripe effects may be obtained with crow weaves or with the 5-harness $\frac{4}{1}$ or $\frac{1}{4}$ twill with 3 and 1 or 4 and 1 arrangements of the colors. The effect is shown in Fig. 44 of a 2 black and 1 white warping and picking with the plain weave. The effect may be reversed, of course, by warping and picking 2 white and 1 black instead of 2 black and 1 white. Fig. 45 shows another effect

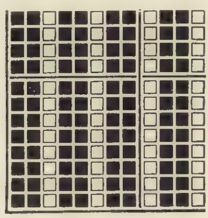

FIG. 43

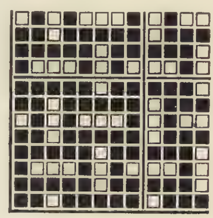

FIG. 44

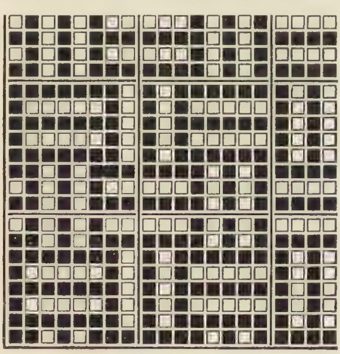

FIG. 45

obtained with the plain weave by warping and picking 2 black, 1 white, 1 black, 1 white. A very unique effect may be obtained with the plain weave by combining the warping

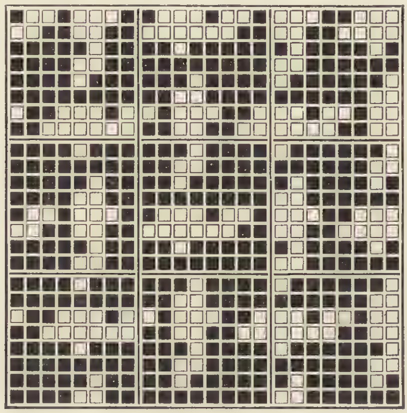

Fig. 46

of Fig. 44 with the picking of Fig. 45. A neat effect is shown in Fig. 46, which is obtained by arranging the yarns 4 black and 2 white in both warp and filling, the weave being

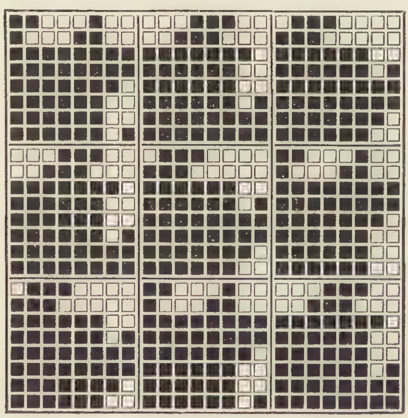

Fig. 47

the cassimere twill. An effect suitable for a suiting pattern is shown in Fig. 47, and is produced by warping and picking the 6-end regular twill 6 black and 2 white.

IRREGULAR THREE-COLOR SIMPLE PATTERNS

24. An effect produced on this plan is shown in Fig. 48, being obtained by warping and picking the 5-end regular twill $\frac{3}{2}$ 2 black, 2 gray, 1 white. Another neat pattern made on this principle and suitable for a suiting or dress-goods

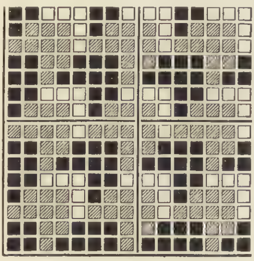

FIG. 48

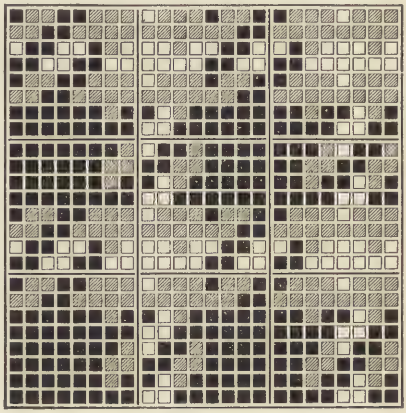

FIG. 49

pattern is shown in Fig. 49. This is obtained with the common 4-harness cassimere twill, the warping and picking being 6 black, 2 gray, 2 white, 2 gray.

IRREGULAR FOUR-COLOR SIMPLE PATTERNS

25. As is the case in all the other simple colorings, a great variety of patterns may be produced with four-color irregular arrangements, one or two of which will be sufficient to demonstrate the style of patterns that may be obtained. Fig. 50 shows an effect obtained by warping and picking 4 black, 2 dark gray, 4 light gray, 2 white. The weave used is the 6-harness regular twill. In Fig. 51, a very neat irregular four-color pattern of a somewhat shaded character is shown, the yarns being arranged 4 black, 2 dark gray, 2 light gray, 4 white, 2 light gray, 2 dark gray in both warp and filling. The weave employed in this effect is an 8-harness twill, shown in Fig. 52.

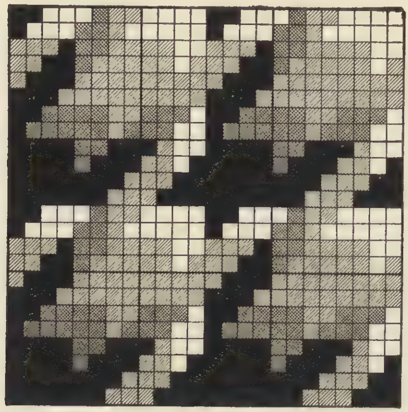

Fig. 50

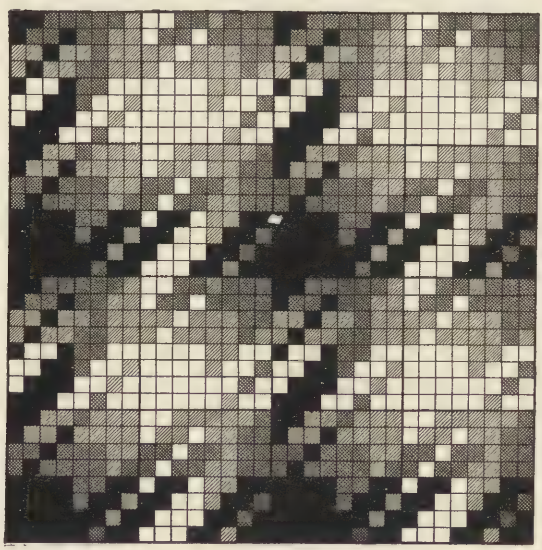

Fig. 51

SUMMARY

26. It will be understood that the regular and irregular colorings given illustrate but a few of the unlimited number of possible and actual patterns obtained with simple colorings. With any of the arrangements given, the colors and yarns may be selected according to the coloring and fabric desired. The weaves, too, may be varied, and in many cases new and original weaves will be found to produce excellent effects. The effects may also be varied by using double-and-twist yarns composed of two single yarns of different colors or by using mixture or fancy yarns instead of solid-colored threads.

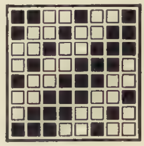

Fig. 52

As far as possible, the colorings given have been what might be termed standard, and many of the effects obtained will be found on the market woven with yarns of various materials and colors. Many of the effects are shown comparatively small on account of the difficulty of illustrating large patterns, but patterns of any extent can be produced by applying the same principles and increasing the number of ends and picks of each color, etc.

EXAMPLES FOR PRACTICE

1. Make a color effect arranged 2 black and 1 white in both warp and filling, the effect to be complete on 12 ends and 12 picks. Show weave used.

2. Make an irregular two-color simple effect with the 5-harness $\frac{3}{2}$ regular twill.

3. How many ends and picks are required to show one repeat of a color effect with the yarns arranged 2 black, 2 gray, 2 black, 1 gray in both warp and filling if the weave used is complete on 8 ends and 8 picks?

4. Show an original three-color irregular simple color effect.

5. Make a color effect with the 16-end regular twill $\frac{2\ \ 2\ \ 1\ \ 3}{\ \ 2\ \ 1\ \ 2\ \ 3}$, the colors to be arranged in both warp and filling 4 white, 2 light gray, 2 dark gray, 4 black, 2 dark gray, 2 light gray.

COMPOUND COLORINGS

27. A **compound coloring** is an arrangement of colors, obtained by combining two or more simple colorings. The effects thus produced are usually quite diversified in composition, the degree of complication varying with the number of simple colorings amalgamated and the number of colors employed. There are *regular* and *irregular* compound colorings similarly as with simple colorings. A **regular compound coloring** is one composed of two or more regular simple colorings, while an **irregular compound coloring** is composed of two or more irregular simple arrangements, or of regular and irregular simple colorings. Compound colorings are also sometimes classified as those composed of two simple arrangements, those composed of three simple arrangements, etc. They are also classified as two-color, three-color, etc. patterns, as was the case with simple colorings.

It is not necessary to give examples of all the different types and styles of compound patterns, and, in fact, from the outline of the numerous types given above, it will be seen that this is hardly possible. Some of the most common patterns and the methods of obtaining them will be explained, however, so that no difficulty will be experienced in making original patterns of any type of compound coloring.

REGULAR COMPOUND COLORINGS

28. In Fig. 53, a compound check is shown made with the cassimere twill by combining 2 and 2 and 1 and 1 simple colorings in both warp and filling. In this pattern, the warp is arranged

$$\left.\begin{matrix}\text{2 black}\\ \text{2 white}\end{matrix}\right\}\text{for 16 ends}$$

$$\left.\begin{matrix}\text{1 black}\\ \text{1 white}\end{matrix}\right\}\text{for 16 ends}$$

The filling is arranged

$$\left.\begin{matrix}\text{2 white}\\ \text{2 black}\end{matrix}\right\}\text{for 16 picks}$$

$$\left.\begin{array}{l}\text{1 white}\\\text{1 black}\end{array}\right\}\text{for 16 picks}$$

It will be noticed that there are four distinct effects formed by this compound order of coloring, since there are two simple colorings combined in both warp and filling. In the upper left-hand corner, the effect is produced by a 2 and 2 warping crossed by a 1 and 1 picking; in the lower left-hand corner, the effect is produced by a 2 and 2 warping and

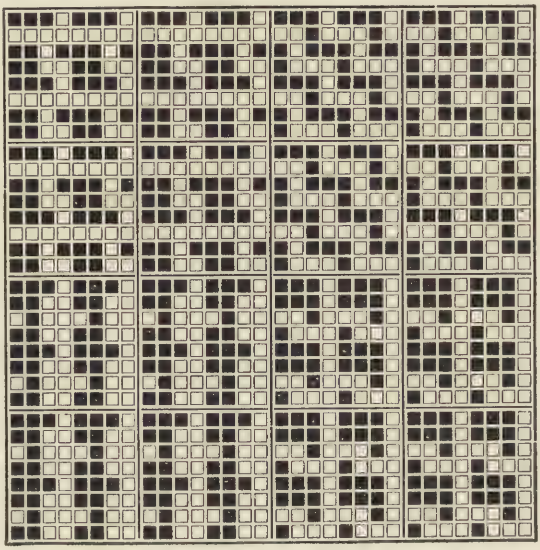

Fig. 53

picking; in the upper right-hand corner, the effect is due to a 1 and 1 warping and picking; while in the lower right-hand corner, the effect is produced by a 1 and 1 warping crossed by a 2 and 2 order of picking. This pattern is suitable for suiting, overcoat, or dress-goods fabrics.

In the effect given, each order of coloring is repeated for only 16 ends and 16 picks, but it will be readily understood that the check may be made larger or smaller by simply repeating each coloring for the requisite number of ends and picks. The checks also may be made of unequal sizes, and it is unnecessary for them to be exactly square unless it is so desired.

In Fig. 54, another check effect is shown, which combines three simple colorings in both warp and filling. In this pattern the yarns in both warp and filling are arranged

$$\left.\begin{array}{l}\text{1 black}\\ \text{1 white}\end{array}\right\}\text{for 12 threads}$$

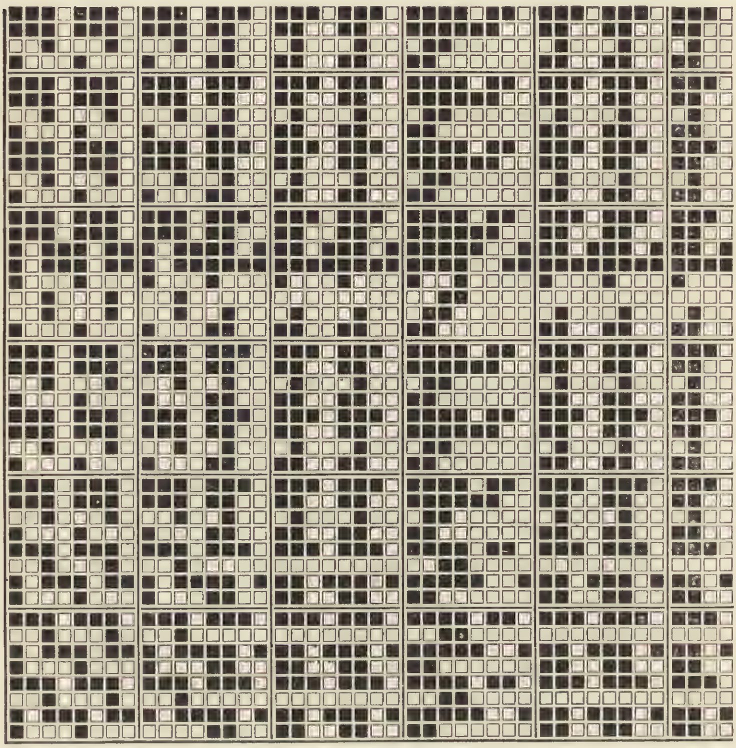

FIG. 54

$$\left.\begin{array}{l}\text{2 black}\\ \text{2 white}\end{array}\right\}\text{for 12 threads}$$

$$\left.\begin{array}{l}\text{4 black}\\ \text{4 white}\end{array}\right\}\text{for 8 threads}$$

$$\left.\begin{array}{l}\text{2 black}\\ \text{2 white}\end{array}\right\}\text{for 12 threads}$$

The weave employed in Fig. 54 is the 4-harness cassimere twill, and the effect produced makes a very neat check. The

size of the pattern is, of course, dependent on the number of times that each order of coloring is repeated. The com-

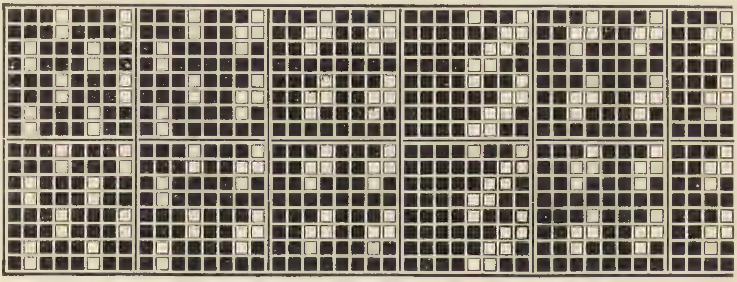

Fig. 55

pound stripe shown in Fig. 55 is made with the same warp coloring and weave as shown in Fig. 54, but with black filling yarn. This produces quite an effective and strong stripe.

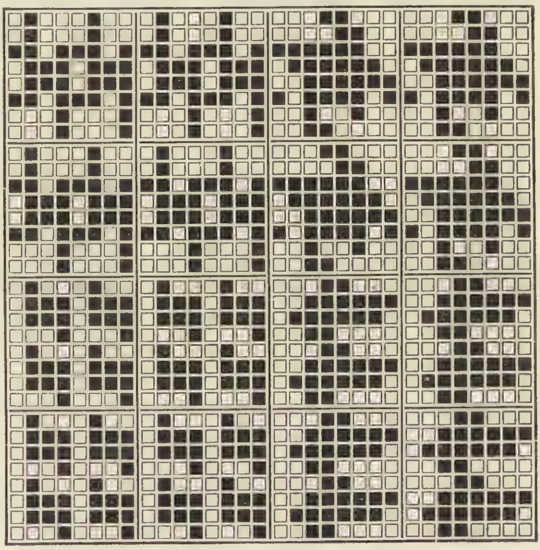

Fig. 56

29. Fig. 56 shows the effect of a compound coloring on a special weave combination. The weave used is shown in Fig. 57, and the colors are arranged in the warp

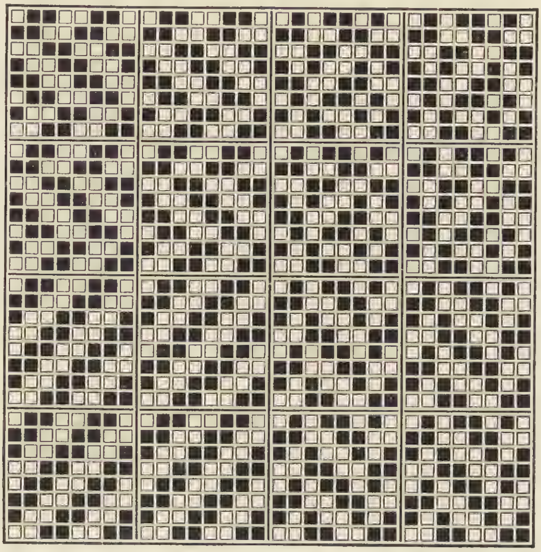

FIG. 57

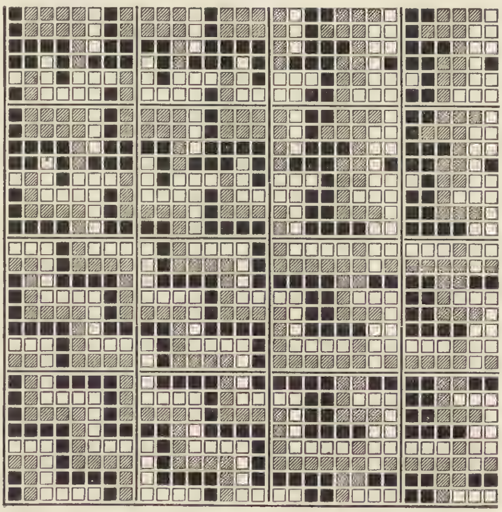

FIG. 58

$$\left.\begin{array}{l}\text{1 white}\\ \text{1 black}\end{array}\right\}\text{for 16 ends}$$

$$\left.\begin{array}{l}\text{2 white}\\ \text{4 black}\\ \text{2 white}\end{array}\right\}\text{for 16 ends}$$

The filling pattern is as follows:

$$\left.\begin{array}{l}\text{1 white}\\ \text{2 black}\\ \text{1 white}\end{array}\right\}\text{for 16 picks}$$

$$\left.\begin{array}{l}\text{2 white}\\ \text{4 black}\\ \text{2 white}\end{array}\right\}\text{for 16 picks}$$

In Fig. 58, an example of a compound coloring with three colors is shown. The warp is arranged

$$\left.\begin{array}{l}\text{1 black}\\ \text{1 gray}\\ \text{1 white}\end{array}\right\}\text{for 18 ends}$$

$$\left.\begin{array}{l}\text{2 black}\\ \text{2 gray}\\ \text{2 white}\end{array}\right\}\text{for 12 ends}$$

The filling of this pattern is arranged

$$\left.\begin{array}{l}\text{1 white}\\ \text{1 black}\\ \text{1 gray}\end{array}\right\}\text{for 18 picks}$$

$$\left.\begin{array}{l}\text{2 white}\\ \text{2 black}\\ \text{2 gray}\end{array}\right\}\text{for 12 picks}$$

The weave is the 6-harness twill $\frac{3}{3}$, and the size of the check is, of course, regulated according to the number of ends and picks on which the colorings are repeated.

In Fig. 58, there are three colors used, while only two orders of coloring are compounded; but in Fig. 59, an effect is shown composed of three colors and three simple orders of coloring and with the same weave. The warp is arranged

$$\left.\begin{array}{l}\text{1 black}\\ \text{1 gray}\\ \text{1 white}\end{array}\right\}\text{for 24 ends}$$

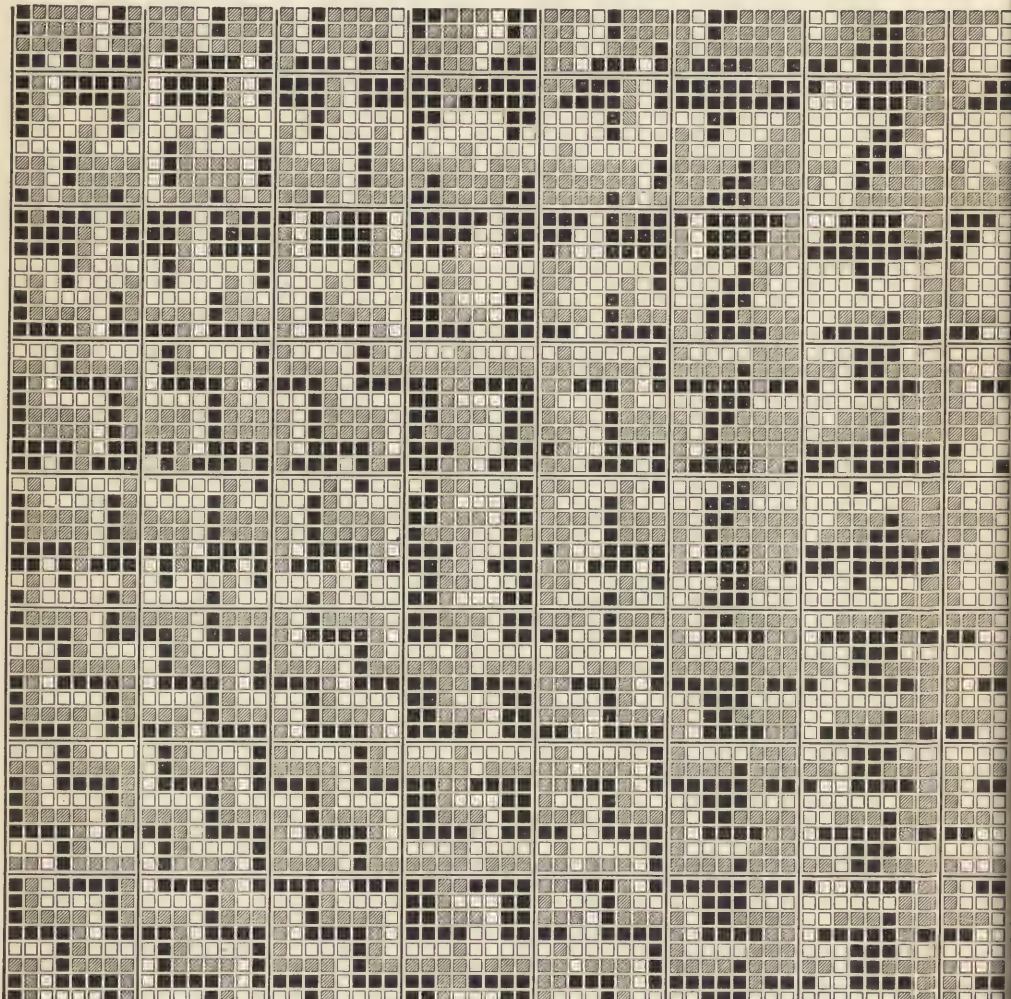

FIG. 59

$$\left.\begin{array}{l}\text{2 black}\\ \text{2 gray}\\ \text{2 white}\end{array}\right\}\text{for 12 ends}$$

$$\left.\begin{array}{l}\text{1 black}\\ \text{1 gray}\\ \text{1 white}\end{array}\right\}\text{for 6 ends}$$

$$\left.\begin{array}{l}\text{3 black}\\ \text{3 gray}\\ \text{3 white}\end{array}\right\}\text{for 18 ends}$$

The filling is arranged as follows:

$$\left.\begin{array}{l}\text{1 white}\\ \text{1 black}\\ \text{1 gray}\end{array}\right\}\text{for 24 picks}$$

$$\left.\begin{array}{l}\text{2 white}\\ \text{2 black}\\ \text{2 gray}\end{array}\right\}\text{for 12 picks}$$

$$\left.\begin{array}{l}\text{1 white}\\ \text{1 black}\\ \text{1 gray}\end{array}\right\}\text{for 6 picks}$$

$$\left.\begin{array}{l}\text{3 white}\\ \text{3 black}\\ \text{3 gray}\end{array}\right\}\text{for 18 picks}$$

IRREGULAR COMPOUND COLORINGS

30. The compound colorings given have been made by compounding regular simple colorings, but some of the best compound patterns are made by compounding irregular simple colorings and also by compounding regular simple with irregular simple colorings. In the latter case, it may be said that the patterns produced are generally more decided and pronounced than when two or more regular or irregular colorings are combined. Fig. 60 shows an irregular compound composed of regular and irregular compound colorings. The weave used is the cassimere twill, and the warp is arranged

$$\left.\begin{array}{l}\text{2 black}\\ \text{2 white}\end{array}\right\}\text{for 24 ends}$$

$\left.\begin{array}{l}\text{4 black}\\ \text{2 white}\end{array}\right\}$ for 12 ends

The filling is arranged on the same system; thus:

$\left.\begin{array}{l}\text{2 white}\\ \text{2 black}\end{array}\right\}$ for 24 picks

$\left.\begin{array}{l}\text{2 white}\\ \text{4 black}\end{array}\right\}$ for 12 picks

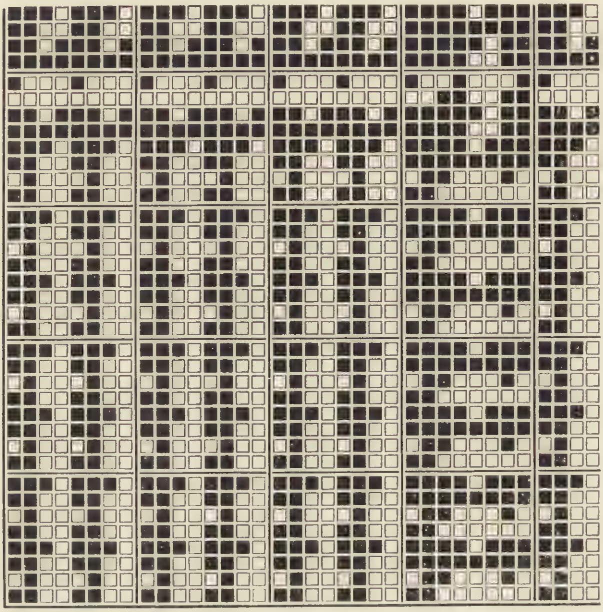

FIG. 60

Fig. 61 shows a very neat and quiet stripe effect produced with the cassimere twill by warping as follows:

$\left.\begin{array}{l}\text{2 black}\\ \text{2 white}\end{array}\right\}$ for 16 ends

$\left.\begin{array}{l}\text{3 black}\\ \text{1 white}\end{array}\right\}$ for 8 ends

$\left.\begin{array}{l}\text{2 black}\\ \text{2 white}\end{array}\right\}$ for 8 ends

$\left.\begin{array}{l}\text{3 black}\\ \text{1 white}\end{array}\right\}$ for 8 ends

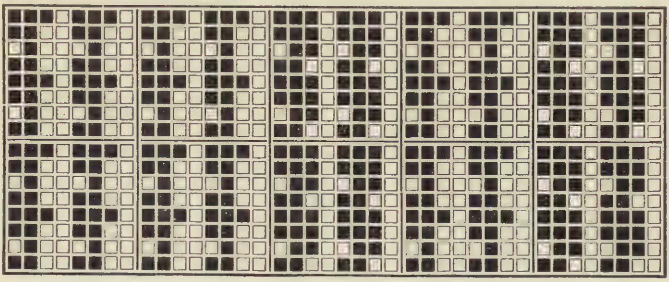

FIG. 61

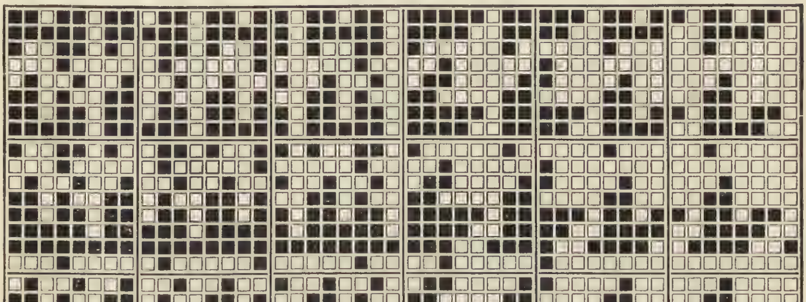

FIG. 62

The filling is arranged in this effect, 2 white and 2 black.

An irregular compound arrangement of colors is used to produce the pattern shown in Fig. 62, consisting of an amal-

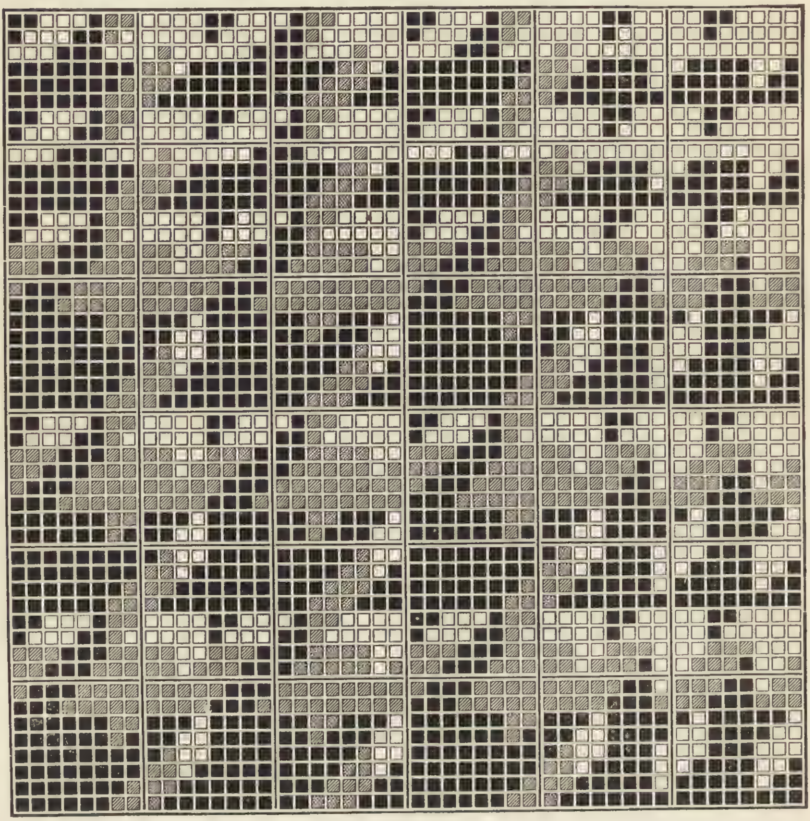

Fig. 63

gamation of three simple colorings. The weave used is the $\frac{2}{1}\frac{1}{2}$ regular twill, and the yarns are arranged in the warp

$$\left.\begin{array}{l}\text{2 black}\\ \text{1 white}\end{array}\right\}\text{for 24 ends}$$

$$\left.\begin{array}{l}\text{3 black}\\ \text{3 white}\end{array}\right\}\text{for 12 ends}$$

$$\left.\begin{array}{l}\text{2 black}\\ \text{4 white}\end{array}\right\}\text{for 12 ends}$$

The filling is arranged as follows:

$$\left.\begin{array}{l}1 \text{ white}\\ 2 \text{ black}\end{array}\right\}\text{for 24 picks}$$

$$\left.\begin{array}{l}3 \text{ white}\\ 3 \text{ black}\end{array}\right\}\text{for 12 picks}$$

$$\left.\begin{array}{l}4 \text{ white}\\ 2 \text{ black}\end{array}\right\}\text{for 12 picks}$$

Fig. 63 shows a compound pattern of irregular nature obtained by the use of three colors. The yarns are arranged in the warp as follows:

$$\left.\begin{array}{l}6 \text{ black}\\ 4 \text{ gray}\\ 2 \text{ white}\end{array}\right\}\text{for 36 ends}$$

$$\left.\begin{array}{l}3 \text{ black}\\ 3 \text{ white}\end{array}\right\}\text{for 12 ends}$$

The filling is placed in the cloth in the same order as the warp, and the weave employed is the 6-harness regular twill $\frac{3}{3}$.

EXAMPLES FOR PRACTICE

1. Make an original compound check effect by combining two simple orders of coloring. Give warp and filling patterns.

2. Make a compound stripe effect with the warp prunelle twill, the warp to be arranged

$$\left.\begin{array}{l}2 \text{ black}\\ 1 \text{ white}\end{array}\right\}\text{for 48 ends}$$

$$\left.\begin{array}{l}4 \text{ black}\\ 4 \text{ white}\end{array}\right\}\text{for 24 ends}$$

The filling is to be arranged 1 white, 2 black.

3. Make an original compound stripe effect combining two simple colorings. Give warp and filling patterns.

4. Show the effect obtained with the $\frac{3}{1}\frac{2}{2}$ regular twill by warping and picking as follows:

WARP PATTERN

$$\left.\begin{array}{l}2 \text{ black}\\ 2 \text{ white}\end{array}\right\}\text{for 32 ends}$$

$$\left.\begin{array}{l}4 \text{ black}\\ 4 \text{ white}\end{array}\right\}\text{for 16 ends}$$

FILLING PATTERN

2 white } for 32 picks
2 black }

4 white } for 16 picks
4 black }

5. Make an original compound stripe effect employing two regular and one irregular simple coloring in the warp. Give warping and picking plans.

COLOR IN TEXTILE DESIGNING

(PART 3)

STRIPES, CHECKS, AND SPOTS

STRIPES

1. Introduction.—The term **stripe** is used in textile designing to indicate the effect produced in a fabric by several bands, or lines (usually, but not necessarily, of different colors) running in the direction of the warp, or from end to end, of the piece of cloth. When the effect runs across the cloth, from selvage to selvage, it is known as a **bar effect** and is not designated by the term stripe unless definitely indicated as a stripe across the cloth. As a general rule, bar effects, or (as they are sometimes called) **barry cloths,** are not satisfactory patterns and are rarely manufactured. Stripes are especially adapted to trouserings and fancy shirtings, and to a less extent to certain classes of dress goods. In suitings, they are not very much in demand, although certain styles have been found to take well. Generally speaking, the style of a stripe is governed by the character of the fabric to which it is applied; thus, for a trousering pattern, small, neat, irregular stripes are in vogue, while for shirtings more prominent effects with stronger colorings are in demand. The very broad stripes of pronounced coloring are limited to tickings and awning ducks, while broad stripes of not very

pronounced coloring are met with in some styles of dress goods. The majority of stripe patterns are due to warp coloring alone, the weave bringing the colored warp ends to the surface in suitable proportions, while the filling is generally of some solid color chosen with a view of either toning down or accentuating the colors of the warp pattern. The number of patterns that can be made, even if only two colors are used, is without limit, since the width of the stripe may be varied from the width of a single thread to stripes several inches in breadth if it is desired, and again, broad and narrow stripes may be grouped in various ways, each new arrangement of the warp yarns forming a new pattern.

The scope and range of stripe patterns, together with the methods of their production, are so varied that great difficulty is experienced in grouping the different effects under appropriate heads. Still it is possible to make two general divisions of the various stripe patterns due to warp coloring alone; namely, *regular* and *irregular stripes*. In the former class may be included those patterns in which the bands of color, without regard to the number of colors used, are of equal widths. In irregular stripes, the size and arrangement of the stripes vary to a great extent. Both regular- and irregular-stripe patterns are very useful in textile designing and very appropriate for certain classes of goods.

REGULAR STRIPES DUE TO WARP COLORING ONLY

2. Two-Color Stripes.—As in regular stripe patterns the lines of color must be of the same width, the scope of designs is somewhat limited in two-color patterns, the only leeway the designer has being in the choice of harmonious colors and in obtaining a suitable width of stripe for the class of goods desired. These are the most elementary stripe patterns and, in fact, the simplest color effects possible to make. Regular two-color stripes are employed in cotton shirtings, ginghams, and tickings to a large extent, but they find only a limited use in the woolen and worsted branches of the textile industry. In order to make

FIG. 1

FIG. 2

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good-selling patterns on this system, great care must be taken to have the effect suitable for the character of the goods and uses to which they are put.

For instance, a neat gingham stripe can be made by arranging the warp 16 ends of white and 16 ends of green and using white filling. This will make each stripe, in a texture suitable for ginghams, about $\frac{3}{16}$ inch in width. The appearance of this pattern in the cloth is shown in Fig. 1, the weave used being plain. On the other hand, a stripe for awning cloth might be arranged 80 ends of orange and 80 ends of white in the warp, and the filling all white. This will make each stripe, in a texture suitable for this kind of cloth, about 2 inches in width. It is always necessary to consider the adaptability of the fabric to the purpose for which it is designed. Regular two-color stripes, being of such simple construction, are generally woven with simple weaves, as the plain weave and 3- and 4-harness regular twills.

The color of the filling always alters the color of one of the stripes when using weaves of this description, since the filling floats on the face of the goods in both stripes and, as in this class of goods the filling is generally of the same color as one of the stripes, that stripe will be of a solid color, while the other will be of a color resulting from the mingling of its own color with that of the filling.

3. **Three-, or More, Color Stripes.**—Regular stripes in three or more colors, while requiring somewhat more skill in arranging the colors harmoniously, are very similar to two-color stripes. Since the weaves used are of the simplest types, as with two-color stripes, no great amount of technical skill is required in the production of patterns of this class. Yet, as more colors are used in the construction of three-, or more, color stripes, it is evident that the patterns produced are somewhat more complicated, and the designer, while not varying the width of the stripes, may use considerable ingenuity in selecting and grouping colors. For instance, suppose that it is desired to get the effect of a red and a green stripe on a white ground and yet have a regular stripe

pattern. If the stripe is arranged so that there will be a white stripe on each side of both the red and the green stripes there will be twice as much white in the pattern as either red or green; this will give the effect of a white ground and yet the pattern will be a regular stripe. This pattern is shown in Fig. 2 as it would appear in the cloth, being woven with the 4-harness twill.

Many groupings of colors can be made with regular stripes, yet, in general, it may be said that the patterns produced are apt to be stiff and bold and the effect rather set. In certain fabrics, however, regular stripes are useful.

4. Regular Shaded Stripes.—Shaded stripes may be produced in regular stripes by using different shades and tints of a color or colors. The pattern may be arranged to vary from a light tint to a dark shade and back again, if desired, simply by employing varying tones of color and arranging them properly in the warp. For instance, the following arrangement of colors will produce a stripe shading from light to dark, and back again to light: Warp, 4 white, 4 light gray, 4 medium gray, 4 dark gray, 4 black, 4 dark gray, 4 medium gray, 4 light gray; filling, either white, black, or medium gray. The color of the filling will, of course, alter the tone of the stripe somewhat, since white filling will lighten all the portions of the stripe except the white ones, while black filling will darken all but the black portions of the stripe. Medium-gray filling will both darken the lighter stripes and lighten the darker stripes.

IRREGULAR STRIPES DUE TO WARP COLORING ONLY

5. Two-Color Stripes.—In irregular stripes, the widest scope is allowed in the choice of patterns and even with only two colors at his command a skilful designer will be able to produce an almost unlimited number of patterns. Irregular stripes due to warp coloring only are produced with simple weaves, as in the case of regular stripes. In Fig. 3, an irregular stripe in two colors is shown. This is a pattern suitable for suitings or trouserings, the warp

FIG. 3

FIG. 4

pattern being 21 dark blue, 1 white, 1 dark blue, 1 white, and the filling all blue. If a less pronounced stripe effect were desired in this pattern, only one white thread might be used instead of two, or blue-and-white twist yarns used instead of pure white. The weave in this pattern is the cassimere twill. One example is sufficient to represent this type of stripe design, since it will be understood that the choice of two colors and their arrangement and quantity offer such chances for variation that many styles are obtained.

6. Shaded Irregular Stripes.—Shaded effects are usually produced in irregular stripes by means of two colors only, the shading being obtained by altering the quantities of color used instead of changing the tone of the color, as is necessary in shaded stripes made on the regular system. In Fig. 4, a shaded blue and white irregular stripe is shown, which will serve to illustrate one method of obtaining a shaded stripe on this principle. The filling is all white and the weave is the warp prunelle. The yarns are arranged in the warp as follows:

White		2		4		6		8		10		10		8		6		4		2	60
Blue	89		5		4		3		2		1		2		3		4		5		118
	Total number of ends in pattern																				178

7. Three-, or More, Color Stripes.—Irregular stripes in three or more colors are made in all classes of textiles in a great variety of forms and colorings. Stripes of this type are found in trouserings, ginghams, tickings, and, in fact, in practically all cloths where a stripe pattern is requisite or desirable. Care must be taken in designing stripes of this type to have the character of the stripe and the coloring suitable for the use to which the fabric is to be put; thus, stripes for trouserings should be small and neat and the colors soft, mellow, and perfectly harmonized, while bed ticking can be made with larger and bolder stripes and with the coloring stronger and more pronounced. In order to tone down the effect of

stripe patterns in trouserings, dark fillings are generally used, black, various shades of slate and blue, and occasionally brown shades being preferred in the majority of cases. In Fig. 5, a trousering pattern is shown that illustrates this class of stripes. This pattern is made with the cassimere twill, the filling being black and the warp arranged as follows:

Black	3																	3
Red-and-black twist		1																1
Dark slate . .			2		2		2		2		2		2		2		2	16
Light slate . .				2		2		2		2		2		2		2		14
Total number of ends in pattern																		34

One more illustration is given of a stripe pattern designed on this system in Fig. 6. This is a pattern suitable for ladies' dress goods or other cloths of like nature and furnishes another example of the wide diversity of patterns possible with stripes of this type. The filling in this pattern is white and the warp is arranged as follows:

Drab	8		8		2		8		8		2		36
Scarlet		2											2
Brown				2		2				2		2	8
Yellow								2					2
Total number of ends in pattern													48

STRIPES DUE TO WARP AND FILLING COLORING

8. It may be said that stripes due to warp and filling colorings may depend, in practically every case, on a suitable weave and a correct arrangement of the colors in the filling

FIG. 5

FIG. 6

The warp and filling patterns may be arranged one and one with any suitable colors, but, as in two-color hair lines, care should be taken to have filling color cover warp color when the warp is down. Fig. 7 shows a four-color hair line made with the warp-flush broken-crow weave; the colors are arranged in the warp one of white, one of light gray, one of dark gray, one of black; and in the filling, one of white, one of light gray, one of black, one of dark gray.

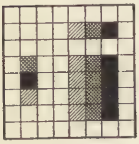

Fig. 7

11. Many stripe effects other than the hair lines may be obtained by the combination of simple warping and picking plans, together with a simple weave. One of these, shown in Fig. 8, is made with the cassimere twill, the warp being arranged 2 black and 2 white and the filling 2 white and 2 black. By altering either the warp or the filling pattern in this stripe, the effect can be made to run in the opposite direction, or from selvage to selvage.

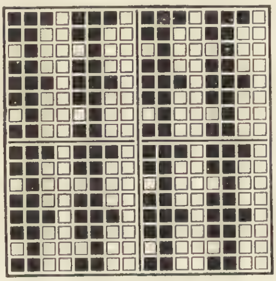

Fig. 8

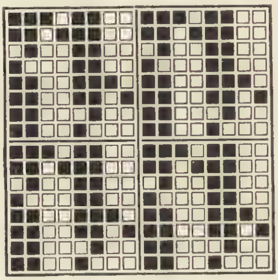

Fig. 9

A similar stripe to that shown in Fig. 8 is shown in Fig. 9. This is obtained with the 8-harness twilled basket weave by arranging the warp 2 black and 2 white and the filling 2 white and 2 black. Many stripe effects can be made on the same principle as Figs. 8 and 9 by using a little ingenuity in color arrangement.

12. Compound Stripes.—Fig. 10 shows a fancy stripe pattern made on the simple hair-line principle with the plain weave. As shown, the stripe consists of bands in which the

hair-line effect runs warp way alternating with bands in which the stripe runs filling way, thus forming a broad stripe effect. The effect is produced by simply varying the warping plan, which, in Fig. 10, is as follows:

$$\left.\begin{array}{l}1 \text{ white}\\ 1 \text{ black}\end{array}\right\}\text{for 16 ends}$$
$$\left.\begin{array}{l}1 \text{ black}\\ 1 \text{ white}\end{array}\right\}\text{for 8 ends}$$

The filling is arranged 1 black, 1 white. The width of the stripes may, of course, be varied at will by altering the warp pattern at the point where it is desired to change the effect.

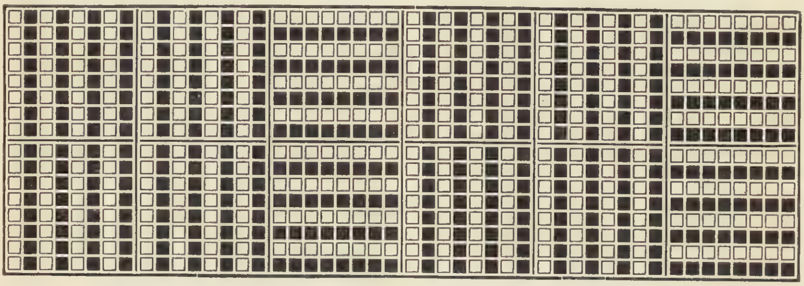

FIG. 10

Another stripe of this class is shown in Fig. 11, being made with the cassimere twill instead of the plain weave. The warp pattern is as follows:

$$\left.\begin{array}{l}2 \text{ black}\\ 2 \text{ white}\end{array}\right\}\text{for 16 ends}$$
$$\left.\begin{array}{l}2 \text{ white}\\ 2 \text{ black}\end{array}\right\}\text{for 8 ends}$$
4 white

The filling is arranged 2 white, 2 black.

Another stripe pattern is shown in Fig. 12; this also is based on the cassimere weave. It will be seen that in the pattern the warp is arranged on a combination of the two and two and the one and one system, while the filling is

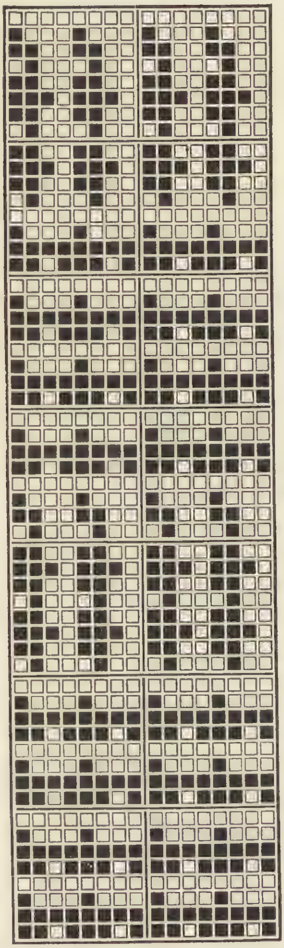

Fig. 11

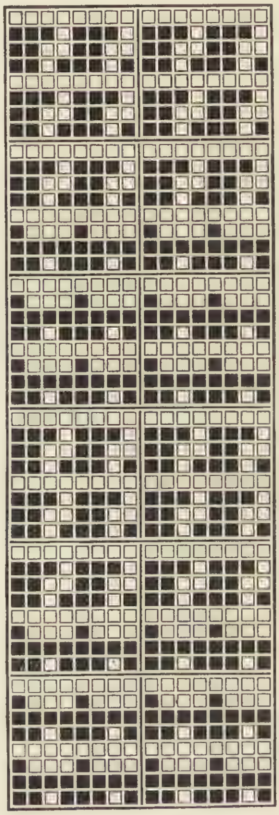

Fig. 12

arranged on the two and two system only. The warp is arranged as follows:

2 black } for 12 ends
2 white }

1 black } for 12 ends
1 white }

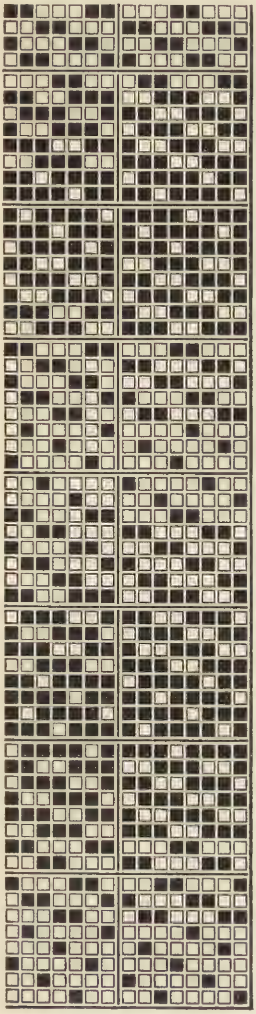

Fig. 13

The filling is arranged 2 white, 2 black.

The examples given of stripe patterns, due to warp and filling coloring combined with a simple weave, are sufficient to explain the method of forming this class of stripes, and it will readily be seen that with some ingenuity on the part of the designer an unlimited number of stripes may be produced in this manner.

STRIPES DUE TO THE WEAVE ALONE

13. Many stripe patterns are due to the weave alone without the use of colored yarns for warp or filling patterns and without using differently colored warp and filling. A good example of this method of producing stripes is found in the satin stripes so common in the cotton trade. These stripes are made by simply combining warp- and filling-flush satin weaves or warp-flush satins with the plain weave. Warp-flush and filling-flush twills and warp-flush twills and plain weaves are also combined in this manner. Although a great number of stripe weaves are woven all one color, there are many patterns that, in addition to the weave design, use colored yarns in the warp either on the regular or on the irregular

system. Often these weaves are woven with a warp of one solid color and a filling of another, thus accentuating the weave effect.

14. Shaded Stripes.—Shaded stripes due to the weave effect alone are made with a shaded-stripe weave and woven with a warp of one solid color and a filling of a different color. Fig. 13 shows two repeats in the ends of a shaded-stripe weave made on a 5-end satin basis and shaded from light to dark and back again to light. For the first 5 ends, the weave is the 5-end filling-flush satin; the next 5 ends, the 5-end satin with one riser added to each of the satin risers; the next 5 ends have two risers added; and the next, three; whereupon the weave grades back to light again. If this weave were woven with a black warp and a white filling, the color effect in the cloth would be exactly the same as the weave in Fig. 13.

EXAMPLES FOR PRACTICE

1. Give a warp and filling arrangement for a regular three-color stripe.

2. Show the effect on 16 ends and 16 picks obtained by warping the cassimere twill 2 white, 2 black and using solid black filling.

3. Give a warp pattern for an irregular stripe in four colors and state for what kind of a fabric it would be suitable.

4. Give warp patterns for two shaded stripes, one made on the regular and one on the irregular system.

5. Make a weave that, if woven with a black warp and a white filling, will produce a shaded stripe.

CHECKS

15. Introduction.—A **check** may be said to be the effect produced in a fabric by several bands or lines, usually, but not necessarily, of different colors, running in the direction of the warp and crossed at right angles by similar bands running in the direction of the filling. In the great majority of cases, checks are produced by crossing a colored warp pattern with a colored filling pattern and generally,

although not always, the filling pattern is the same as the warp pattern. The pattern may be of the very simplest construction, being complete on a few ends and picks and with only two colors, or it may be very complicated and require many ends and picks and many colors. Checking may be applied to almost any class of fabric and in silks, cottons, linens, woolens, and worsteds it is a standard method of applying color. Check designs that are in any way complicated in composition are most generally known as **plaids** when woven in woolen, worsted, or silk. In the cotton trade, the term **gingham** generally implies a check effect unless a *striped gingham* is especially designated.

16. Although there are many systems of forming check patterns and the number of patterns that may be produced is without limit, there are certain elements that govern all check patterns:

1. In order to produce a perfect and regular check, the filling pattern should be the same as the warp pattern, provided that the fabric is squarely built, that is, with approximately as many picks as ends per inch. If there are less picks than ends per inch in the fabric, the number of picks of each color in the filling pattern should be correspondingly reduced so as to keep the bands of color in the filling of approximately the same width as those in the warp, thus making the checks square. In this connection it may be noted, however, that many patterns having a slightly greater length than width make a better appearance than when exactly square, since a check that is actually square often appears broader than it really is. This applies more to large check patterns than to small ones. The difference in the length and width of a check pattern should never be excessive, but when a difference does exist, the pattern should have a greater length than width.

2. If the check is to be a perfect one, the weave used should be such that the warp and filling will be equally flushed at regular distances on the face of the fabric. The reason for this is that if a warp-flush weave is used, the warp pattern

will show much more prominently on the face of the goods in proportion to the amount of the warp on the face and, vice versa, if the weave is a filling-flush, the filling pattern will show more prominently than the warp. It is because of this that the plain weave and cassimere and 6-harness twills are largely used for developing the best check and plaid effects.

The check effects generally met with may be roughly divided into two classes; namely, those into the composition of which only two colors enter and those composed of three or more colors. The former class is by far the larger, considering the quantity of the patterns on the market, but the latter class includes some of the best and most popular plaid and check patterns.

TWO-COLOR CHECKS

17. Common Checks.—The simplest possible check effect is produced with a simple weave and equal quantities of two colors in both warp and filling. An example of what is known as the **simple**, or **common, check** is shown in Fig. 14. This is a common, or *staple*, gingham pattern made with the plain weave and arranged twelve threads of blue and twelve threads of white in both warp and filling. Checks of this nature are made not only in cotton, but in all kinds of textile fabrics. The weaves generally employed are the plain, cassimere twill, 6-harness regular twill, and various basket weaves.

18. Common-Check Modifications.—Common checks may be easily varied so that the entire effect will be changed by simply altering the arrangement of the colors to a very slight extent. For instance, if the simple check in Fig. 14 is altered by running a narrow band of blue through the center of each white stripe and a band of white of the same width through the center of each blue stripe in both warp and filling, the effect of the pattern is totally changed, as shown in Fig. 15. The pattern of both warp and filling for this sample is as follows:

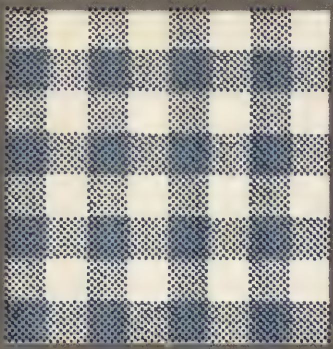
Fig. 14


Fig. 16


Fig. 15


Fig. 17

Blue	6		6		2		14
White		2		6		6	14
Total number of ends or picks in pattern							28

Anotber and even more simple modification of the common check is made by altering the number of ends and picks of each color. Thus, if the warp and filling patterns of the common check in Fig. 14 were changed to 6 blue and 18 white, the appearance of the pattern would be totally different, as shown in Fig. 16.

19. Overchecks.—A common, or simple, check may be easily modified by means of overchecking. An **overcheck** may be defined as a large square marked off by a few threads in the warp and filling patterns and enclosing smaller squares of the check effect. If the common check shown in Fig. 14 is modified by a white overcheck, the effect is as shown in Fig. 17. The warp and filling patterns for this check are as follows:

Blue	6		6		12		24
White		2		12		12	26
Total number of ends or picks in pattern							50

The size of the overcheck may, of course, be varied at will and the pattern may also be overchecked with blue by dividing white stripes. The reason for modifying the common check in so many ways is that a common check presents a stiff appearance and lacks diversity, especially if the size of the check is at all large. Therefore, the more the colors are broken up, the softer will be the effect, even if only two colors are used.

20. Counterchange Checks.—In a counterchange check, the colors are reversed in different parts of both the

warp and filling patterns; that is, the number of threads is the same, but one color is inserted in the place of the other. The effect of this is to make certain portions of the pattern the exact reverse of other portions. For instance, if the first half of the pattern is arranged 6 white, 6 black, 12 white, the last half of the pattern will be arranged 6 black, 6 white, 12 black; that is, with the arrangement the same but with the colors counterchanged.

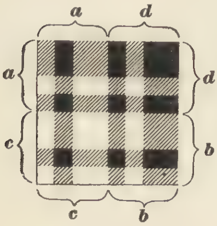

FIG. 18

Fig. 18 shows a counterchange check made with the above pattern in both warp and filling. It will be seen that the portion of the check marked *a* is the exact reverse of that portion marked *b* and, similarly, *c* is the reverse of *d*; that is, where the pattern is white in one portion, it is black in the other and vice versa. Counterchange checks, like common checks, may be modified in many ways. In Fig. 19, a modification of the pattern in Fig. 18 is shown. This is obtained by dividing each broad black band of color in both warp and filling with a few white threads and each broad white band with a few black threads. The warp and filling patterns for Fig. 19 are as follows:

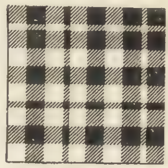
FIG. 19

White	6		6		6		6		2		26
Black		6		2		6		6		6	26
Total number of ends or picks in pattern											52

It will be noticed that, while Fig. 19 is a modification of Fig. 18, the counterchange character of the check is still retained. Fig. 18 could also have been modified by dividing the narrow black and white bands, or both systems could have been united and an even more complicated check obtained, although still retaining the counterchange feature.

21. Compound Checks.—The compound system of checking is commonly met with in all classes of designs. These checks are made by combining two or more systems of warping and picking. For instance, Fig. 20 shows a compound check made with three systems of warping and picking. The pattern is as follows:

16 black
16 white
$\left.\begin{array}{r}\text{8 black}\\ \text{8 white}\end{array}\right\}$ for 32 threads
$\left.\begin{array}{r}\text{4 black}\\ \text{4 white}\end{array}\right\}$ for 32 threads

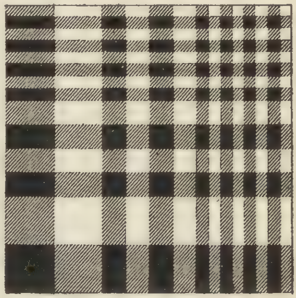

FIG. 20

Compound checks may be modified in many ways, which the ingenuity of the designer will readily suggest. The following pattern is a modification of the pattern in Fig. 20 and, as shown in Fig. 21, produces a far better check:

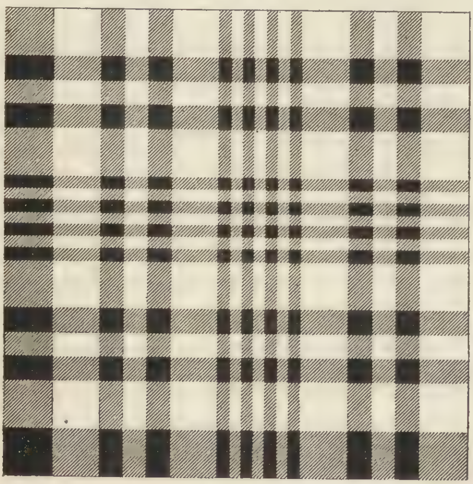

FIG. 21

16 black
16 white
$\left.\begin{array}{r}\text{8 black}\\ \text{8 white}\end{array}\right\}$ for 32 threads
8 white
$\left.\begin{array}{r}\text{4 black}\\ \text{4 white}\end{array}\right\}$ for 32 threads
12 white
$\left.\begin{array}{r}\text{8 black}\\ \text{8 white}\end{array}\right\}$ for 32 threads
8 white

Many styles of compound checks are obtained with the cassimere and 6-harness twills by grouping four and four and two and two colorings in the former case and six and six and three and three colorings in the latter case.

22. Shaded Checks.—Shaded-check effects may be produced in two colors by two methods: (1) By graduating the warp and filling patterns so that they will shade from dark to light and back again to dark if desired; (2) by

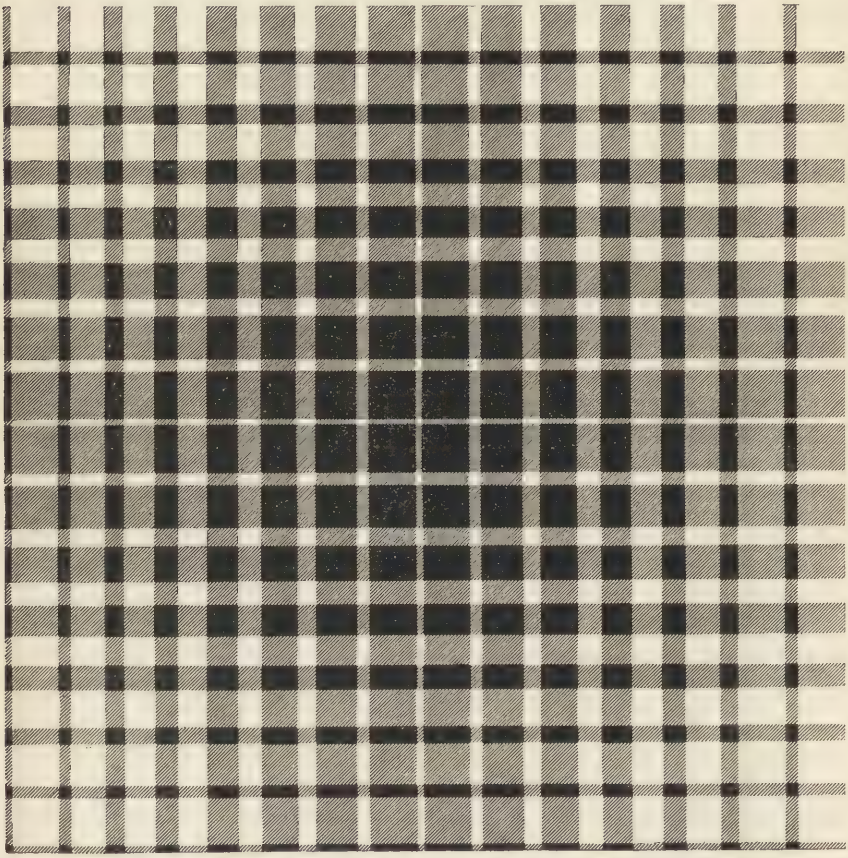

Fig. 22

using a shaded check weave. The following warp and filling pattern produces a neat shaded check effect according to the first method. This pattern is shown in Fig. 22. It may be subjected to modifications as, for instance, by grading the colors in larger stripes, say by fours,

or it may be arranged with only half the number of threads of one color in each instance; that is, 2 black, 8 white, 4 black,

Black	2		4		6		8		10		12		14		16		16		14		12		10		8		6		4		142
White		16		14		12		10		8		6		4		2		4		6		8		10		12		14		16	142
Total number of ends or picks in pattern																															284

7 white, etc.; but in this latter case a pick-and-pick loom will be required.

Shaded checks may be produced by using a shaded weave with a warp of one color and a filling of another. In Fig. 23,

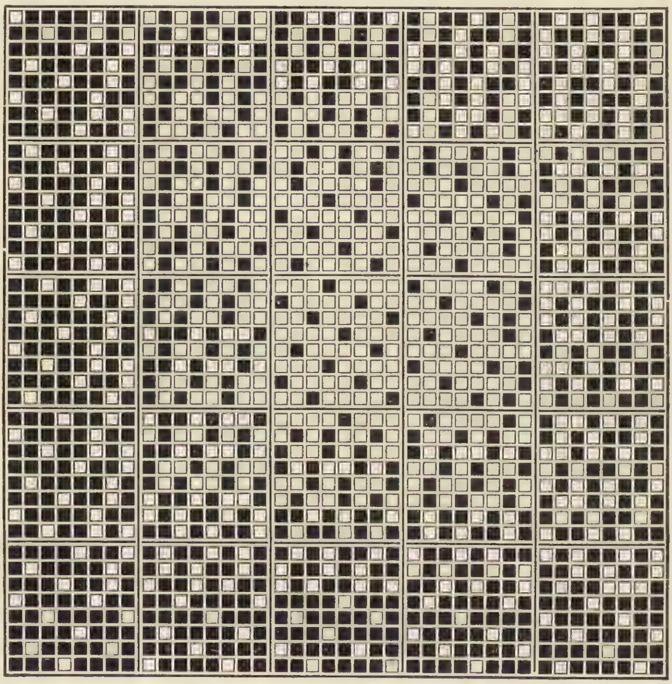

Fig. 23

a shaded weave suitable for producing checks by this method is given. The weave is made by adding risers to a

5-end satin base. A novel check effect may be obtained by combining into a check design shaded squares made on the aforesaid principle, but so constructed that the center of one square will be light and that of the next one dark.

THREE-COLOR CHECKS

23. When three or more colors are employed for checking, an almost endless variety of patterns can be easily made and, in general, it may be said that the patterns produced are more complicated, ingenious, and diversified than those obtained with only two colors. Check effects made on this principle are found in almost every class of textile fabrics where checks are of value, and may vary in size, arrangement, and coloring according to the character of the fabric to which they are applied.

24. Common Three-Color Checks.—The check shown in Fig. 24 and known as the **common three-color check** is the simplest form of a three-color check and, although not so stiff as the two-color common check, it is a stiff pattern

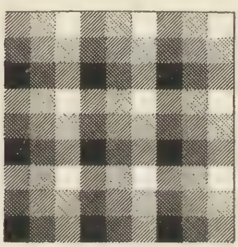

FIG. 24

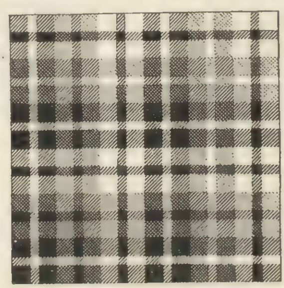

FIG. 25

and is liable to lack the neatness of the two-color common check. The pattern of Fig. 24 is arranged 8 black, 8 gray, 8 white in both warp and filling. Generally, better results are produced with this class of checks if small effects rather than large ones are made.

25. Modifications of Three-Color Common Checks. This style of checking may be modified in a similar manner to that explained in connection with the two-color common

check. In Fig. 25, a modification of Fig. 24 is shown; it is obtained by dividing each black band in both warp and filling with a narrow band of white, each white band with a narrow band of black, and every alternate band of gray with narrow bands of black and white. The pattern for this modification is as follows:

Black . .	4		4		2			2		4		4					2		22
Gray . .				4		4							4		4				16
White . .		2					4		4		2			2		4		4	22
Total number of ends or picks in pattern																			60

Many other modifications may be devised; for instance, each black stripe might be altered by dividing with white and each white stripe with black, leaving the gray stripe intact.

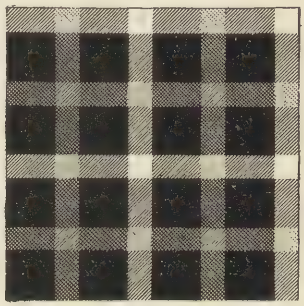

Fig. 26

26. Set Checks.—Another modification of the common check is known as the **set check**; this is obtained by increasing the number of ends and picks of one of the colors. The effect of this is to produce predominating spots of that color at regular intervals, thus obtaining the set effect. Fig. 26 is a set check produced from Fig. 24 by doubling the width of the black bands of color in warp and filling and arranging the warp and filling patterns as follows: 16 black, 8 gray, 16 black, 8 white. Set checks are not very useful in the ordinary run of textile designing, on account of the stiff appearance of the pattern; they may, however, be used for a base and modified so as to produce effects more diversified in character.

27. Compound Checks.—Compound checking with three or more colors yields the largest diversity of patterns

of any principle employed. These checks result from crossing a compound warping pattern (composed usually of several orders of coloring) with a similar filling pattern. The effects produced are often of a large and showy nature, as, for instance, in the Scotch plaids, or tartans; and again they may be small and neat, as in some cotton gingham patterns. A good three-color compound check is shown in Fig. 27. The arrangement of the colors is as follows:

$$\left.\begin{array}{l}8\text{ black}\\ 8\text{ white}\end{array}\right\}\text{for 32 threads}$$
$$\left.\begin{array}{l}4\text{ gray}\\ 4\text{ white}\end{array}\right\}\text{for 24 threads}$$
4 white

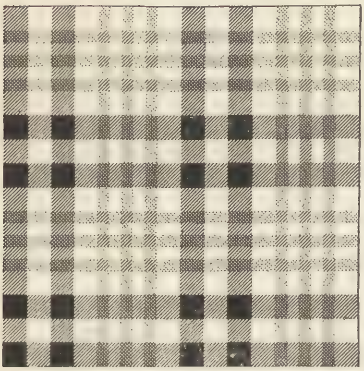

Fig. 27

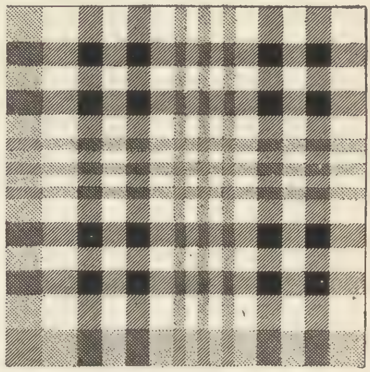

Fig. 28

Another neat check pattern on this system is shown in Fig. 28, the arrangement of warp and filling being as follows:

12 gray
12 white
$$\left.\begin{array}{l}8\text{ black}\\ 8\text{ white}\end{array}\right\}\text{for 32 threads}$$
$$\left.\begin{array}{l}4\text{ gray}\\ 4\text{ white}\end{array}\right\}\text{for 24 threads}$$
4 white
$$\left.\begin{array}{l}8\text{ black}\\ 8\text{ white}\end{array}\right\}\text{for 32 threads}$$
4 white

Checks of this description may be varied in many ways, as, for instance, by substituting one color for another, by overchecking, by dividing certain broad bands of color with a narrow band of color, etc. In Fig. 29, another compound check in three colors is shown, which illustrates a pattern very frequently met with in a wide range of fabrics. The warp and filling arrangement for this effect is as follows:

16 white
6 black
6 white
6 gray
6 white
6 gray
6 white
6 gray
6 white
6 black

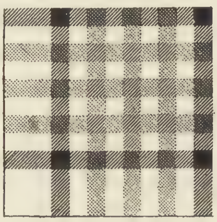

Fig. 29

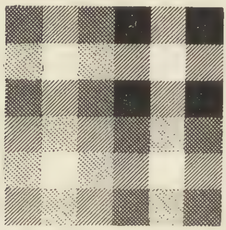

Fig. 30

28. Three-Color Counterchange Checks.—Counterchange checks may be made in three colors in a manner similar to that employed with two colors. The effect of the counterchange, however, is less perfect, on account of the more complicated nature of the pattern due to the use of three colors. Fig. 30 shows a counterchange check in three colors. The yarns are arranged as follows:

12 gray
12 white
12 gray
12 black
12 white
12 black

29. Shaded Checks.—Effects of a shaded character are produced in patterns employing three or more colors by using yarns of different shades, the quantity of each color being the same or, in many instances, being varied. The following warp and filling pattern will produce a shaded check design according to this method and serves to illustrate the principle employed:

56 white
8 light gray
8 medium gray
8 dark gray
8 black
8 dark gray
8 medium gray
8 light gray

30. Scotch Plaids.—The Scotch plaids, or tartans, are renowned for the beauty of their coloring and the ingenious arrangement of the different colors. Strictly speaking, the word *tartan* implies a woolen or worsted plaid cloth, but the same colorings are woven in silk and fine cottons as well as in worsted. The weave most generally employed is the cassimere twill, although the plain and other simple weaves are sometimes used. Each Scottish clan has its own particular tartan and the arrangement of the colors is distinctive of that clan. Some clans have two plaids, one for ordinary occasions and another for dress. The following are the warp and filling patterns of the tartans of a few of the more important clans, and which are frequently used in fabrics manufactured for the trade:

CAMPBELL OF ARGYLE

26 dark green
2 black
4 yellow
2 black
26 dark green
26 black
24 dark blue
4 white
24 dark blue
26 black
164

ROYAL STUART

12	red
4	black
6	red
6	white
6	red
4	black
12	red
16	blue green
6	black
4	white
6	black
4	yellow
12	black
10	blue
18	red
10	blue
12	black
4	yellow
6	black
4	white
6	black
16	blue green
184	

GORDON

28	black
6	Scotch blue
6	black
6	Scotch blue
6	black
24	Scotch blue
8	black
8	Scotch blue
8	black
8	Scotch blue
28	black
34	Scotch green
8	yellow
34	Scotch green
28	black
28	Scotch blue
6	black
6	Scotch blue
6	black
28	Scotch blue
28	black
34	Scotch green
8	yellow
34	Scotch green
418	

NOTE.—Scotch blue is a blue with a greenish hue composed of 75 per cent. of normal blue mixed with 25 per cent. of green. In the same manner the Scotch green is composed of 75 per cent. of green mixed with 25 per cent. of blue.

MACGOWAN

22	black
10	red
46	green
44	red
46	green
10	red
46	black
44	red
24	black
292	

MACPHERSON (DRESS)

36	dark gray mix
6	red
6	dark gray mix
6	red
36	dark gray mix
26	black
8	dark gray mix
10	black
4	yellow
10	black
8	dark gray mix
26	black
182	

NOTE.—The dark gray mixture yarn in the MacPherson tartan is composed of 90 per cent. black and 10 per cent. white.

Campbell of Breadalbane

26	black
42	Scotch green
2	black
6	red
2	black
42	Scotch green
26	black
44	Scotch blue
2	black
6	yellow
2	black
44	Scotch blue
244	

Black Watch, or 42d Highlanders

26	black
28	Scotch green
6	black
28	Scotch green
26	black
26	Scotch blue
6	black
6	Scotch blue
6	black
26	Scotch blue
184	

These patterns are those of only a few of the many Scotch clans, but as the patterns given are the more common ones they are sufficient for illustrating the general character of these plaids. Fig. 31 shows the appearance of the Campbell of Argyle plaid. It is customary by the trade to call all patterns resembling the Scotch plaids by that name whether they are true plaids or not.

EXAMPLES FOR PRACTICE

1. Make an original check effect and state to what class of checks it belongs.

2. State a suitable warp and filling pattern for a shaded check in two colors.

3. Make a common check and show the effects of at least two modifications of it.

4. Make a compound check effect.

SPOTS

31. Spots are almost invariably developed by means of special weaves, such as have been described. The coloring of each fabric, therefore, varies with the character of the weave. In the case of spot weaves in single cloths, the fabric is generally woven a solid color or else piece dyed after being woven white. Sometimes, however, the warp is

Fig. 31

of one color and the filling of another, in which case the color of the spots depends on whether it is made by a warp or a filling flush in the weave.

In extra warp spot effects the ground cloth is generally of a solid color, although it may be ornamented with a separate pattern of its own, and the extra warp ends are colored according to the color of the spot desired. Thus, an extra warp spot design might be arranged with the warp and filling of the ground cloth white and the extra warp ends blue, in which case the weave would be such as to form a blue spot on a white ground. In the same way extra filling designs are arranged usually with the warp and ground picks of one color and the extra, or figuring, picks of another color with which it is desired to produce a spot on the ground color. Spotted effects are sometimes produced in the cloth by the use of spotted fancy yarns, but the patterns and effects so produced are not true spots, but rather give the fabric the appearance of a mixture or an all-over effect.

DESIGNING IN GENERAL

DUTIES OF A DESIGNER

1. Picking out and reproducing a sample of cloth and originating new weaves should not be considered as all the requirements of a good designer, as there are many other things that must be understood before one can become competent in this branch of textile work. In fact, the more a person learns of all the branches of textile manufacturing, the better designer he will become, since if he understands the processes through which the fibers pass before becoming cloth, and the results of these processes, he will be better able to judge what combinations are best to form a fabric. By this it is not meant that to become a designer one must know the best methods of setting the different parts of all the machines in a mill, but that one should be able to judge whether or not the product of any machine is suitable for the purpose for which it is intended, and have some knowledge of the theory and principles on which the machine is operated.

In addition to this, a designer should be a constant student of the market, in order to know what effects and designs are especially salable, for although it is not usually the case that the designer has complete authority to manufacture any grade or quality of cloth that he may desire, his opinions in regard to these points are often sought.

It is a good plan for a student of designing to have a large sample book in which samples of cloth and their pick-outs may be kept. These will be a great aid when obtaining new weaves and new combinations of colors, for although the fashions of the previous season may not prevail

the next year, many good points may be obtained from cloths kept in this manner. Designers of long experience are well aware that there is a cycle of fashions in textile fabrics; that is, after a period of years, certain styles of goods come into favor again. The fabrics of today may have been in vogue 8, 10, or 15 years ago and, in most cases, will be worn again in a similar period. Thus, the history of previous seasons' styles, as found in the old pattern books of the mills or in books or periodicals formerly published containing reproductions of fabrics then in fashion, are well worth the attention of a designer.

In addition to being conversant with the different kinds of yarn manufactured in his own mill, the designer will find it an advantage to understand yarns generally, as, for instance, those in which different materials are combined, since in many cases such yarns will be found in a fabric. Samples of cloth are often sent to the mill by the selling agent with directions to reproduce them in certain lines; that is, it may be desired to produce a fabric that will be similar to the sample in appearance and yet can be sold at a lower price; in other cases it may be desired to use a sample simply for its combination of colors, or for its weave; while in still other cases orders may be given to the designer to reproduce the sample exactly. In short, it may be said that the primary duties of a designer are to reproduce samples of cloth and originate new weaves, while, in order to do this correctly, it is advisable that he should understand all the processes involved in the making of perfect cloth.

DESIGNING DEPARTMENT

2. Different mills adopt different arrangements for their designing departments, since those that would be best for a mill arranged to make certain kinds of cloth would not be suitable for a mill that manufactured an entirely different class of fabric. However, if the processes explained are understood, one should be able to adapt oneself to any methods that may have to be dealt with.

The **designing department** of a mill usually consists of at least two rooms—one for the designer and his assistant, if an assistant is employed, and one termed the *weave room*, in which the samples are woven. In many mills, however, the designer has but one room, while the samples are woven in the regular weave room of the mill, although it is better to have a separate room for weaving these samples; the best plan is to have adjoining rooms with glass windows between, in order that the designer may have direct supervision over the weave room even while performing his other work. This department should be in a part of the mill where good light may be obtained, and it is also an advantage to have the walls painted white.

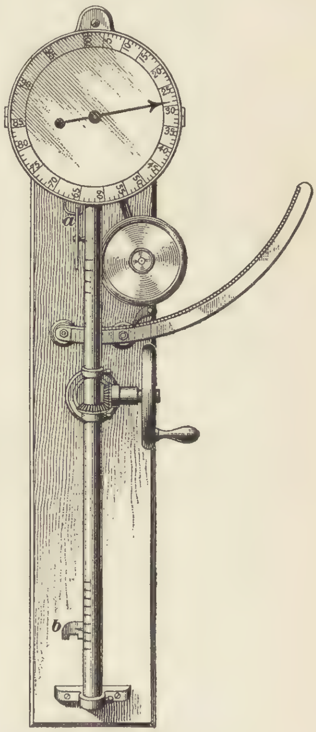

FIG. 1

3. Equipment of Designer's Room.—To aid in measuring and folding the cloth samples, the designer should be supplied with a long, flat table, while he should have another table, known as an examining table, for use when inspecting the samples after they are woven. The top of the examining table should be inclined at an angle of from 30° to 40°; one-half should be painted black and the other half white, in order to provide a dark surface for inspecting light-colored cloth and a light surface for inspecting dark cloth. This table should be situated in such a position that the person examining the cloth will have a good light on his work. The designer should also be provided with a yarn, or wrap, reel with which to obtain accurate lengths of yarn, as well as

yarn and cloth scales for weighing yarn and cloth when determining the counts of yarn or the weight of cloth.

4. A *yarn-testing machine* similar to that shown in Fig. 1 is necessary, in order to ascertain whether the strength of the yarn being used is up to the standard. To operate this machine, a skein of yarn—usually containing 120 yards

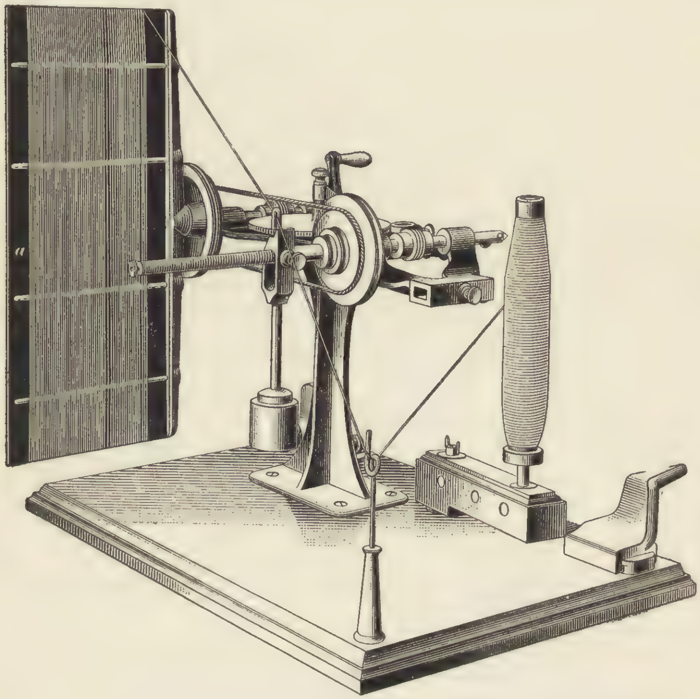

FIG. 2

when testing cotton and 80 yards when testing worsted—is first wound on the wrap reel, and then placed on the two hooks *a*, *b* of the yarn-testing machine; by turning the handle until the yarn breaks, its breaking weight is shown by means of the finger on the dial.

Another type of yarn-testing machine, which may better be termed a *yarn-examining machine*, is shown in Fig. 2. In this

machine, the yarn is wound from a bobbin or cop on to a card *a* in such a manner that there will be only one layer of the yarn. When thus placed on the card, any imperfections, such as thin places, specks, etc., will be readily noticed, since white yarn may be wound on a black card and black or dark-colored yarn on a white or gray card.

Various types of *cloth-testing machines* are employed for the purpose of determining the strength and elasticity of the fabric. In the manufacture of a large variety of cloths these items are an important matter, while in many cases orders placed with the mill stipulate the strength and elasticity that the cloth shall have; this is especially the case with the manufacture of army goods. Breaking tests afford a fairly accurate proof of whether the bleaching processes through which cotton and linen goods have passed have been rational ones; that is, whether the goods have been weakened or not. Although there are a number of makes of these machines, almost all are operated on the same principle. The cloth is held between two clamps and by turning a handle is distended until it tears, its strength being registered by a pointer on a dial, much the same as in the case of the yarn-testing machine.

5. A designer should be supplied with record books in which to keep samples of all the weaves produced, in order to have an accurate record. These record books, which may be considered another style of sample book, if carefully numbered and indexed, so that any style or pattern may be readily referred to, will be a good guide when making new samples.

Sample cards of yarns should be kept; these are simply strips of cardboard around which are wound samples of each color or counts of yarn that the mill is using. These cards are so arranged that they will enable the designer to see at a glance what colors are at his disposal; they are also of some aid when desiring to learn how the colors will look when arranged in the cloth. Yarns are frequently arranged in books, which, in this case, serve the same purpose as the cards.

In addition to the articles mentioned, there should be a supply of layout sheets on which to make out directions for warping the yarn for the cloth samples; also, pick glasses, pick-out needles, and design paper.

6. Equipment of Weave Room.—The designer's weave room should contain all the articles and machines necessary for making samples of cloth from the yarn. In many cases, the different counts and colors of yarn made in the mill are placed on bobbins, cops, or small spools that are kept in boxes or drawers in the designer's weave room. These boxes should be labeled on the outside, to show the colors and counts of yarn that they contain. They should be kept systematically and should be readily accessible, so that when it is desired to make a warp there will be no difficulty in finding the proper yarn. Almost every designer's weave room contains a warping arrangement by means of which the designer may have his own warps made. As these warps are not generally over 9 yards in length, the saving in expense and trouble when made in this manner will be apparent.

The weave room should also contain looms on which the sample warps may be woven. These looms should be capable of reproducing any kind of cloth made in the mill; that is, if the mill is running dobby work, it is necessary to have one or more dobby looms, and if running box work, it is necessary to have box looms. Each loom should be located near a separate window, in order to supply good light to the weaver.

Each loom in the weave room should be attended by at least one man, known as a pattern weaver. If the sample warps are made in this room, there should also be a man for this purpose. Although there should usually be a fixer for the purpose of putting in the warps, building the harness and box chains, and keeping the looms in good running order, in many cases, where only one or two looms are employed, a fixer may be dispensed with, as the weaver himself may be competent to look after this part of the work with the aid of the designer.

METHODS OF PRODUCING SAMPLES

ORIGIN OF NEW STYLES

7. It is very seldom that the designer has complete control over the class of goods that the mill makes, as in the majority of cases the selection of a new line of goods is dependent on the opinions of either the agent or the commission house.

In America today, the styles of cloth manufactured are to a large extent derived from the styles of Europe, and consequently it is an advantage to a person in this country to know, as soon as possible, what styles and fashions are selling in Europe. There are several French firms with headquarters in Paris and branch offices in the United States that make a business of selling foreign samples to the mills. In other cases, samples are sent direct from Europe; some of the larger mills keep agents there permanently for this purpose, while others send men there occasionally to obtain ideas. As many lines of goods that are fashionable in Europe one season are in vogue in America the next, the advantage of obtaining these samples is obvious.

In the cotton trade, rough sketches of desirable fabrics, accompanied by directions for producing samples, are frequently sent to the mill by the commission house. This is usually done where small striped effects are desired, such as satin stripes combined with other weaves. In such cases, the width of the different stripes is designated and the other details left to the designer.

TRIAL SAMPLES

8. When a line of samples is sent to the mill, the designer first looks them over and selects those that in his opinion it will be possible for the mill to make, each of which he then considers separately with a view to reproducing it as accurately as possible. The first step is to dissect the sample in order to ascertain the weave and the arrangement of the

yarns in both the warp and filling. Then, if it is found that the cost of manufacturing such cloth is satisfactory and that it is possible to obtain the necessary yarns for it—of the

STYLE A. A.

50^s Warp 40^s Filling 72 Picks 84 Ends 39.06 Reed 4 Harness 9 Yds. Slashed.

Patt. 1

White	36		5			5		5				5		5			5	
Blue		24			4				4		4				4			24
Black				2						2						2		
Red							2						2					

Patt. 2

White	36		5			5		5				5		5			5	
Black		24			4				4		4				4			24
Blue				2						2						2		
Red							2						2					

Patt. 3

White	36		5			5		5				5		5			5	
Red		24			4				4		4				4			24
Blue				2						2						2		
Black							2						2					

Patt. 4

White	36		5			5		5				5		5			5	
Black		24			4				4		4				4			24
Red				2						2						2		
Blue							2						2					

Patt. 5

White	36		5			5		5				5		5			5	
Blue		24			4				4		4				4			24
Red				2						2						2		
Black							2						2					

Patt. 6

White	36		5			5		5				5		5			5	
Red		24			4				4		4				4			24
Black				2						2						2		
Blue							2						2					

FIG. 3

correct color, counts, and quality—the necessary specifications are made out.

The samples to be made from these specifications are known as **trial samples** and are comparatively small,

sometimes not more than 6 inches wide. When this is the case, it is generally the custom to make up a number of samples in one warp, known as a *blanket warp*. For example, suppose that a number of patterns, each 6 inches wide, are to be made with the same warp. The first 6 inches in the width of the warp will consist of one sample, the next 6 inches will consist of another, and so on until the whole width of the warp is occupied. In Fig. 3, which gives the specifications for a blanket warp, there are six warp patterns of the same style that differ only in the arrangement of the colors. When all the samples in a trial warp are of the same style, all the ends have the same drawing-in draft and also the same chain draft. There are cases, however, in which different styles are placed in the same warp, and it then often becomes necessary to have more than one drawing-in draft, and often the chain draft is changed so that certain samples may be woven with a different weave.

9. Warping the Yarn.—After the specifications have been made out by the designer, they are given to the person who makes the warps. The spools, bobbins, or cops containing the yarn of the required colors and counts are then selected from the boxes and placed on a creel, similar to that shown in Fig. 4, in their proper order; that is, in such a manner that the ends may be taken from them in the order in which they are to be arranged in the warp. For example, suppose that a warp is arranged 4 white and 4 black. Then four spools containing white yarn will be so placed in the creel that they can be taken first by the person making the warp, and the four spools containing black yarn will follow.

Fig. 4 shows sufficient bobbins for a single repeat of a warp pattern arranged 4 ends black, 2 ends gray, 2 black, and 2 white. The first bobbin is placed on the back row of pegs, the second on the front row of pegs, the third on the back row, the fourth on the front row, and so on. The ends are then taken from each row in successive order; that is, the first end comes from the first bobbin on the back row, the second end from the first on the front row, etc. The

ends from the bobbins on the back row are passed behind a wire *b*, while those placed on the front row are passed behind a wire *a*. The ends are then passed to the top of the creel and threaded through eyes *c*. By arranging the ends in this manner, the person making the warp can easily form a lease so that the drawing-in hand may find the separate ends readily.

10. Fig. 5 shows a warping arrangement that is in general use. In many cases this consists simply of pegs inserted in the wall of the room, around which the yarn from the

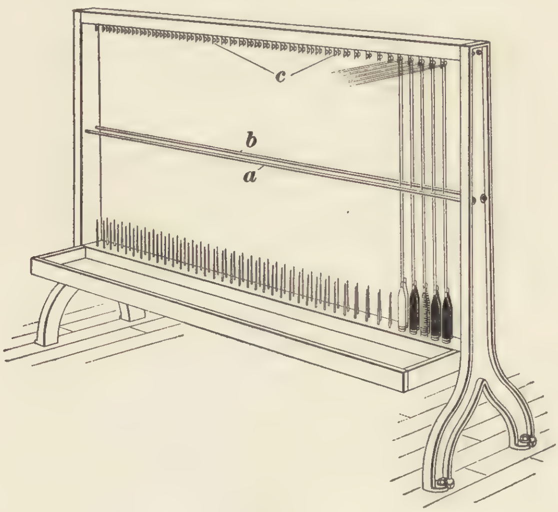

Fig. 4

bobbins can be passed, but in other cases it consists of a rectangular frame attached to the wall as shown. The person making the warp first ties the ends together and slips them over the peg *a*; he then selects the ends from the creel in their proper order, and makes a lease by passing the first end over the thumb and under the forefinger of the right hand, the next end under the thumb and over the forefinger, etc., in this manner separating the even-numbered from the odd-numbered ends. After the lease is made, it is passed over pegs *b*, *c* in the same manner that it was passed around

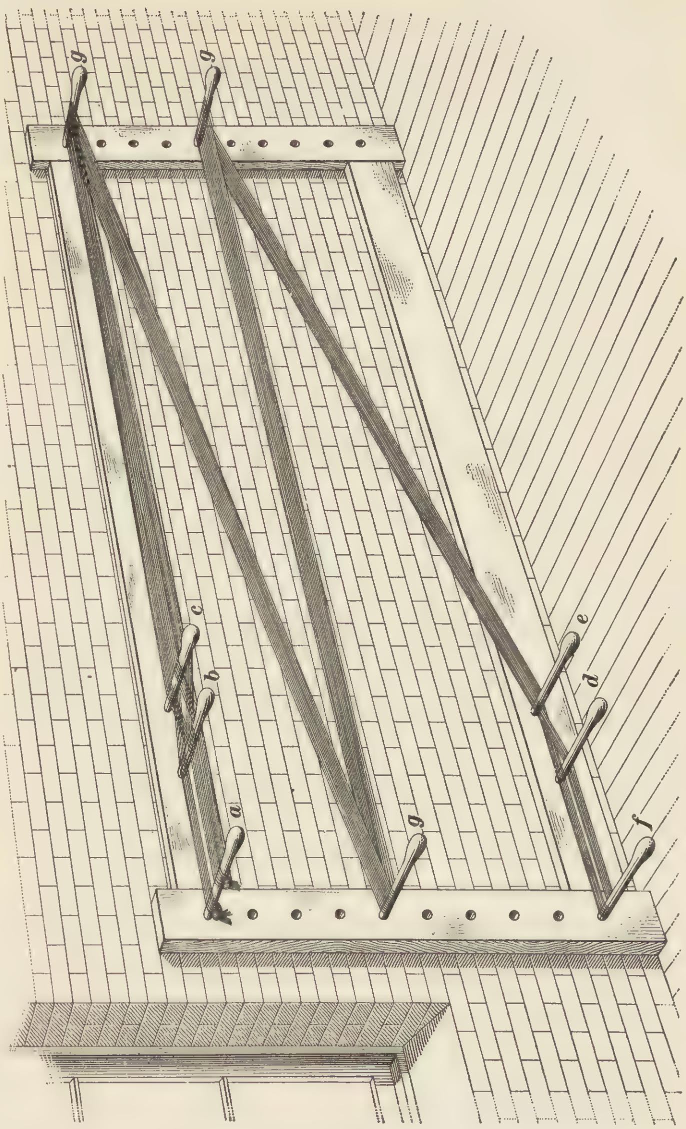

Fig. 5

the thumb and forefinger; as these pegs serve to hold the lease of the warp, they are termed *lease pegs*. All the yarn is then passed around the pegs *g* until it comes to the pegs *d*, *e*; here it passes under the peg *e*, over the peg *d*, then around *f*, back under the peg *d*, and over the peg *e*. By this means another lease is formed of sections containing a greater number of threads than in the case of the pegs *b*, *c*, which separated the yarn thread by thread. This last lease is formed simply for the purpose of spreading the warp more evenly on the beam. From the peg *e*, the yarn passes back around the pegs *g* in reverse order until it reaches the pegs *b*, *c*, where a lease is again formed and the ends then knotted around *a* and cut. The manner in which the warp yarn is wound around the pegs places twice as many ends on the warper as are taken from the creel each time that the yarn is passed back and forth, since it commences and ends at the same point. The length of the warp is governed by the number of pegs *g* that are used.

The number of bobbins shown in Fig. 4 is by no means the limit of the number that can be used at once, as several repeats of the warp pattern may be placed on the creel at one time. Suppose, for illustration, that the warp for one sample is to contain 480 ends and that one pattern is arranged as shown in this figure, containing 10 ends; also, that four of these patterns are taken from the creel at one time. 40 ends are therefore first passed around the pegs together and then brought back, which gives 80 ends of the warp. The person making the warp then selects the ends for the four patterns the second time and passes them around the pegs and back again, which gives 80 more ends, or 160 altogether. This is repeated a sufficient number of times to give all the ends in the warp. As in this case there are to be 480, the ends from the cops must be passed around the pegs five times in order to give the required number.

If another sample consisting of different colors, or a different arrangement of the same colors, is to be warped on the same beam, it will be necessary to rearrange the spools or cops for this sample. This operation is repeated until the

different samples are warped. In some cases a special thread, such as a double and twist, is inserted between each two samples in the same warp in order to designate the point where two samples join.

11. Beaming the Yarn.—When taking the yarn from the warper, the regular lease rods used in drawing-in should be inserted in place of the pegs *b*, *c*. The warp is then taken from the pegs and wound on the loom beam. In case the warp is not to be beamed as soon as it is taken from the warper, a string, or lease band, may be inserted in place of the lease rods, thus allowing the warp to be wound in the shape of a ball. The loom beam generally rests on stands in such a manner that it can be turned by hand; the end of the warp is spread out, and the ends of yarn thoroughly straightened, after which it is wound on the loom beam. Sometimes as an aid to straightening the ends, a coarse heckling comb is used, the ends being spread evenly in the comb and drawn through the dents as they are wound on the beam.

12. Drawing In and Weaving.—After the warp has been beamed, it is taken to the drawing-in room, where it is drawn through the harnesses and reed, according to the specifications. In some cases, the warp may be drawn in the designer's weave room, although no expense is saved by adopting this method, as the drawing-in of the sample warp is as much a regular process as the drawing-in of any regular warp for the weave room.

After being drawn in, it is sent back to the designer's weave room ready to be woven. The beam is then placed in the loom and the harnesses tied up ready for weaving, after which the necessary chains are built and placed on the loom and the first sample woven.

In case several samples with different fillings are combined in a warp, it is necessary to weave one sample at a time. Suppose that one sample contains a filling pattern of 4 black and 4 white, and another a filling pattern of 8 white and 8 black; it is not possible, of course, to weave both of these

patterns at the same time, since each has a different arrangement of filling. Therefore, when one pattern is being woven, the rest of the patterns in the warp will be of no use. These are termed *hybrids* and are generally thrown away; in some cases good samples are obtained from them, but this is the exception rather than the rule. After the first sample has been woven with the necessary filling, the second is woven. This necessitates at least the changing of the filling and, in some cases, the building of a new box chain, while in very rare instances, where the sample warp contains different styles, a new harness chain is also necessary.

13. Tying Over.—Suppose that there are six patterns in a sample warp and that each is woven with its own filling pattern; then six regular samples will be obtained. In many cases, however, it is an advantage to change even the warp yarn in the sample warp; that is, after the six regular samples have been woven, it may be left to the discretion of the designer to arrange different combinations of colors, using the same weave. When this is the case, it is much cheaper to simply tie over the warp ends that it is desired should be changed rather than make and draw in an entirely new warp.

To illustrate this point more fully, suppose that a certain pattern in the warp is arranged 4 black, 2 gray, 2 black, and 2 white and it is desired to change the 2 ends of gray to a different color. The manner in which this is accomplished is as follows: The harnesses through which the ends of gray are drawn are raised, while all the others are lowered, thus allowing the ends of the gray to be readily accessible. A spool of the yarn to be substituted for the gray is placed on a wire rod over the loom. Two ends of gray are then broken out and the end of one of them that is connected to the woven cloth is attached to the end from the spool. This new end is carried some distance from the back of the loom around any suitable object and then back again to the other end of gray, to which it is attached after being broken from the spool. When all the gray ends have

been tied in this manner, the loose ends of gray that were broken out are drawn down under the beam and a weight attached to them, in order to prevent their passing up over the whip roll into the lease rods. The operator, after detaching the new ends from the object around which they were passed at the back of the loom, picks up the ends of gray in front of the reed with a wire rod, and draws them through the harnesses and reed until the new ends that have been tied to them reach the fell of the cloth. These new ends are then fastened at the front of the loom by means of 2 or 3 picks of filling, while at the back of the loom a weight is attached to the ends to keep them tight during weaving.

In some cases the ends of the warp are tied over at the front of the loom instead of at the back. When this method is adopted, the ends to be tied over are broken out in front of the reed and the new ends attached to the ends coming from the beam, after which they are drawn through the reed and harnesses to the back of the loom, leaving a sufficient length of yarn in front of the reed, however, to allow the new ends to be attached to the cloth by a few picks of filling. After the ends have been tied over, the desired pattern of filling is placed in the loom and another sample of cloth woven. Other samples may be readily produced in the same manner, and thus a large number of trial samples obtained from one warp. For example, suppose that a sample warp contains six original patterns and that each pattern is tied over three times; then twenty-four regular samples will be obtained from the one warp.

14. After the entire warp has been woven in this manner, the cloth is taken from the loom and carried to the designer's room, where it is measured and weighed. It is then taken to the finishing room and after passing through the necessary processes is brought back again to the designer's room and again measured and weighed. All the items obtained should be inserted in a book where they can be readily referred to, in order that information regarding the effects of the different processes may be readily accessible.

The cloth is then cut up into samples and the best of them selected to be sent to the commission house. Several samples from this lot may be selected by the commission house as being suitable to put on the market.

SELLING SAMPLES

15. After a certain number of trial samples have been selected, it is necessary to make what are termed **selling samples.** These selling samples are generally woven the same width as the regular cloth, and should pass through the same processes, since only by this means can there be obtained the necessary information in regard to the appearance of the finished cloth and the cost of manufacture. From these selling samples the agents' sample books are made, and it then remains with the selling house to place orders for the different samples of cloth.

16. After an order has been obtained for the mill it is the designer's duty to make out all specifications that may be necessary for the reproduction of the desired cloth. Those relating to the warping, beaming, and drawing-in departments of the mill should be sent to their respective overseers, while all the specifications regarding harness drafts and chain drafts should be sent to the overseer of the weave room. When the cloth is first started in the weave room, the designer should see that the first pieces taken off are correct in every particular, after which it may be safe to assume that his duties regarding that special line of goods are completed.

CONCLUSION

17. Designing is by no means a modern art. The textile museums of world-wide renown, such as those in Florence (Italy), Crefeld (Germany), or the Museum of Fine Arts in Boston, contain fabrics manufactured centuries ago that exhibit skill in designing, taste in coloring, and knowledge of cloth structure equal to most modern fabrics. It is not possible for every designer to visit such museums,

but in many of the public libraries in the larger cities there are books on decorative art or historic ornament in which many of these fabrics are reproduced; an examination of these often leads to the formation of new ideas and is certainly a part of the education of a designer.

Textile designing is an art that has been developed to a high degree in Europe, and the products of English, French, and German designers are justly esteemed. It is therefore advantageous to designers in American mills to keep in touch with what is being done in Europe; a knowledge of the French or German language often aids a designer in this, by enabling him to study French or German textile-designing publications. This, however, is secondary to securing a thorough knowledge of the manufacturing conditions. A designer should never cease to study these—from the raw material to the finished fabric—so that he may have a knowledge of all the processes that lead up to the production of the fabric, and thus learn how to obtain the most artistic effects in the most economical manner.

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NOTE.—All items in this index refer first to the section and then to the page of the section. Thus, "Checks 85 12" means that checks will be found on page 12 of section 85.

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